



The Blast Furnace and Steel Plant

Published the first of each month by the National Iron and Steel Publishing Co.

Main Office — Thaw Building, 108 Smithfield Street, Pittsburgh.

DISTRICT OFFICES — NEW YORK AND CHICAGO.

President: H. A. Andresen. Vice President: R. E. Densmore. Secretary: P. G. Moore. Treasurer: F. C. Andresen.

Engineering Editor:
ALFRED M. STAEHLE.

Associate Editor:
A. W. PETERSON.

EDITORIAL ADVISORY BOARD:

William A. Field

W. Trinks

Kenneth B. Lewis

Barton R. Shover

Dr. George B. Waterhouse

A. G. Smith

Fred Crabtree

Subscription Price:—In the United States, \$1 per year; Canada, \$1.50; all other countries, \$2. Single Copy, 15 Cents.
Entered as second-class mail matter at Pittsburgh, Pa., under the Act of Congress, March 3, 1879.

Index to Contents

VOL. VI.

AUGUST, 1918.

No. 8.

	Page
NEW INSTALLATION FOR ROLLING ALLOY STRIPS	319
UTILIZATION OF BASIC OPEN HEARTH SLAG	322
PRINCIPAL CHANGES IN BLAST FURNACE LINES	323
BY J. G. WEST, JR.	
COPPER TUYERES FOR BLAST FURNACES	329
BY A. K. REED.	
BY-PRODUCT COKE OVEN PRESSURE REGULATION	331
BY CHARLES H. SMOOT.	
OPERATION OF MOTOR-DRIVEN CONTINUOUS MILLS	336
BY H. C. CRONK.	
PROBLEMS OF STEAM CYLINDER LUBRICATION	338
BY W. F. OSBORNE.	

	Page
TESTING AND INSPECTION OF REFRACTORY BRICK	341
BY C. E. NESBITT AND M. L. BELL.	
DISCUSSION OF ARTICLE ON POWDERED COAL	345
PRODUCTION TOPICS	346
NEWS OF THE PLANTS.....	347
SOME POINTERS ON BY-PRODUCT COKE OVEN OPERATION	348
INDUSTRIAL SAFETY	349
OPEN HEARTH	350
WITH THE EQUIPMENT MANUFACTURERS	352
TRADE NOTES, TRADE PUBLICATIONS, OBITUARY, SOCIETY MEETINGS	354

The Blast Furnace ^{and} Steel Plant

New Installation for Rolling Alloy Strips

Increasing Use of Alloys Stimulate New Departure in Strip Mill Practice—The National Pressed Steel Company, Massillon, Ohio, Builds New Plant.

Within the last few years the use of alloys in steel making has passed beyond the experimental stage into standard use and practice. It has been the means of establishing new industries and developing new machinery and new methods. In one product the evolution has promoted a plant totally different to any heretofore devised. It is the installation at Massillon, O., of the plant of the National Pressed Steel Company, which was specially designed and built for rolling strips by an improved method and practice for a wider range of uses in standard and alloy steels.

With this in mind a group of young men familiar with the difficulties incident to the deep drawing, stamping, forming and pressing of steel products, and also the need for new and better qualities, set out to build a mill to meet the new demands. Their aim was to produce a wider range of sizes and the proper quality and physical characteristics in hot and cold rolled strips especially adapted to this particular class of work.

Representative lots of steel intended for stamping and similar purposes were carefully examined by microscope, analysis and other methods, all of which indicated the fact that while in the past research work has been carried on to improve the composition of steels in general, and that while some attention had been given to scale elimination, etc., very little thought had been given to the subject of mechanical treatment. This investigation and careful research convinced the designers that new methods and practice were necessary.

All the information and data obtained pointed to the necessity for a departure from standard machinery, methods and practice. Before designing the machinery, equipment and plant, which for the new purposes required many innovations in heating and rolling, it was considered necessary to consult the trade purchasing and using this class of steel in order to obtain complete data and authentic information.

An abstract was accordingly prepared containing 37 questions, each one important to the establishment

of the new methods thought necessary, and so prepared as to require little time and effort in giving the answers. This was sent to a large number of manufacturers producing pressed and drawn steel specialties, and brought forth immediate and enthusiastic response. The returns reached 47 per cent which answered in whole or in part the entire abstract.

With the complete data and reliable information then at hand bearing on size, finish, analysis, quality, physical characteristics, etc., the design of this unusual plant was undertaken by the company's own men, carefully adhering to basic principles. In spite of adverse conditions in material and machinery markets, weather, etc., in 10 months and one day from the time ground was broken the plant was in operation.

This plant, with its special equipment, new methods and practice is now producing a material of such physical property and quality that without any annealing it can be used in a great many cases where formerly annealed strips were considered a necessity.

Raw material is received in the form of slabs and billets and is unloaded from the cars by means of cranes carrying rectangular lifting magnets. Before any material is placed in stock or used, each piece is carefully inspected for seams, pipes or any other defects which could be rolled into the steel by later manipulation and not detected until the material was in the customer's presses. The stockyard has a capacity of from 15,000 to 20,000 tons of steel and adjoins the mill building.

Great care and attention were given to the design and detail for the furnaces to insure uniform heating. They are of the large continuous reheating type, using powdered coal as fuel. All parts and accessories were specially designed and constructed for this method of heating. Pushers, drawing machinery, door hoists, transfer tables and all equipment auxiliary to the furnaces are electrically operated. The steel is transferred to the roughing mill in a unique manner and in such a way that practically all furnace scale is removed.

NATIONAL PRESSED STEEL COMPANY STRIP MILLS

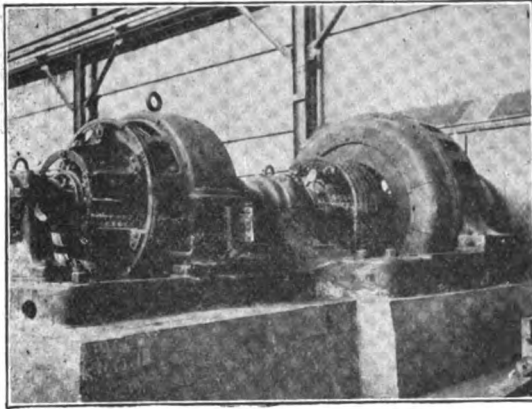


Fig. 1 (above) shows a Westinghouse motor. As in the case of the motor driving the universal mill, this motor was also designed especially to meet the requirements of this particular installation.

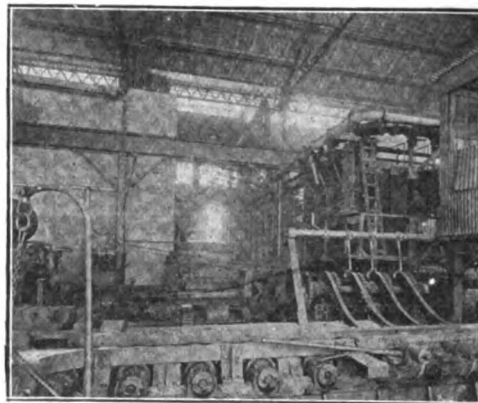


Fig. 2 (above) is a view of the Westinghouse reversing mill motor, which was designed and built especially for this installation.

Fig. 3 (below) shows a partial end and side view of the No. 1 heating furnace with a portion of the mill approach table, roller table and of the delivery end of the slab transfer in the foreground. Above the top of the furnace may be seen the pipes through which is conveyed the air and powdered coal, by means of which the furnace is heated.

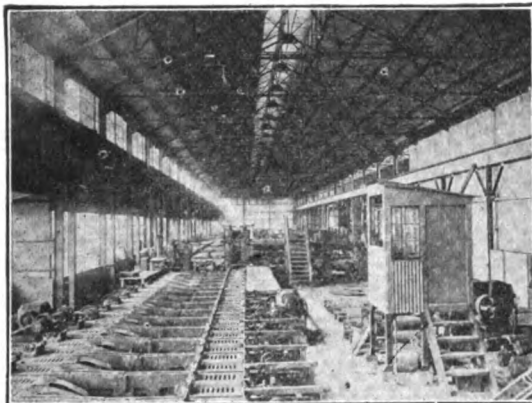
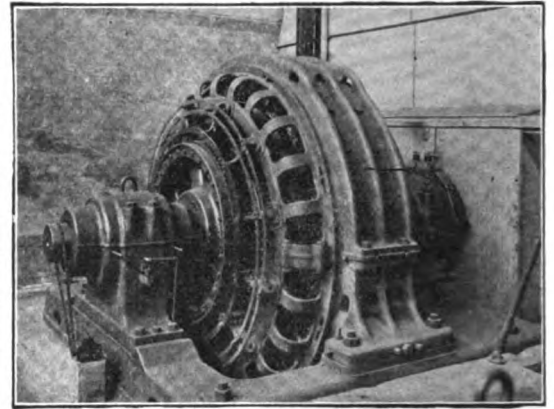


Fig. 4 (to the left) shows the transfer tables serving the 16-inch finishing mill. The Westinghouse motor used for driving this mill is shown in Fig. 1.

Fig. 5 (to the right) shows the motor generator set. The motor shown in Fig. 2 is provided with a solid steel plate flywheel to enable it to carry the peak loads. The rim of this flywheel travels more than four miles per minute.

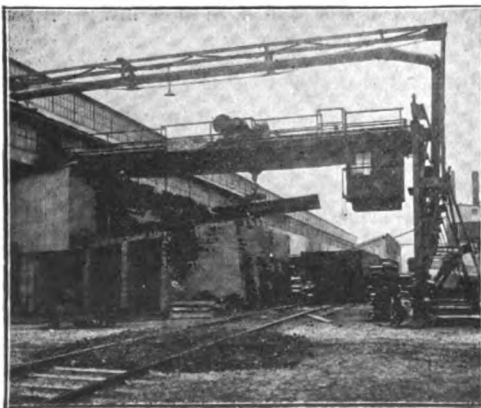
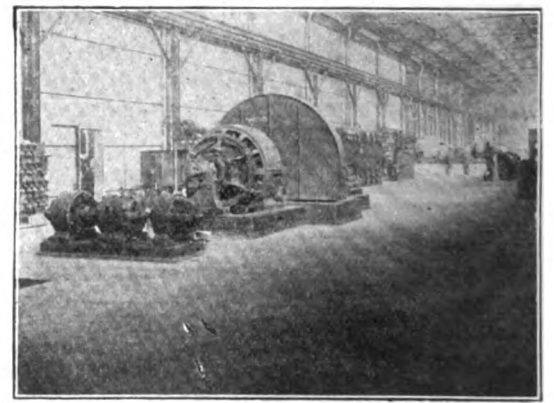
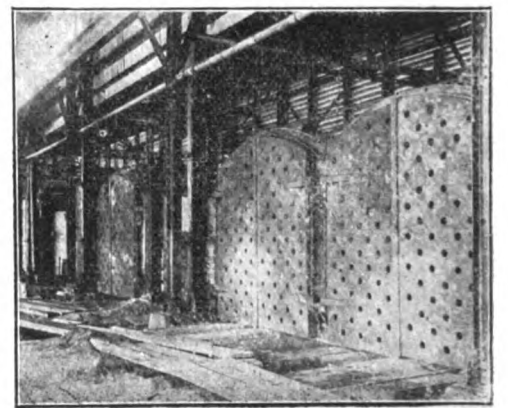
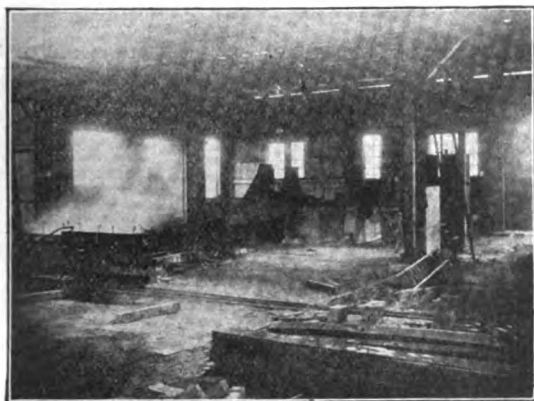


Fig. 6 (to the left) shows a view of the charging end of No. 1 heating furnace, together with the electric overhead traveling crane serving it. The slabs are picked up by this crane by means of a magnet and placed on the skids in front of the massive pushers. These machines are of unusually heavy design and are electrically controlled and operated. As hot slabs are drawn for rolling, cold ones are pushed into the furnace at the rear or charging end.

Fig. 7 (to the right) shows several of the heating furnaces.



The roughing mill is a high speed 24-inch two-high universal mill and is driven by a Westinghouse reversing motor similar to those used in blooming mills but smaller and much faster. An idea of the extreme proportions of the mill will be conveyed by the statement



View of pickling department.

that the housings weigh approximately 42 tons each, and that all other parts are correspondingly heavy. When it is borne in mind that this company produces large quantities of special alloy steels in the form of strips up to No. 00 gage by 24-inch wide, the necessity for such heavy units will be appreciated. The extreme rigidity of the mill and foundations are also realized upon considering that when finishing .50 carbon steel less than one-thousandth inch is allowed for spring of the mill. The vertical rolls on this mill are designed and operated so that proper side work may be given the steel. This method of rolling also holds the width dimension to slight variation.

If the material is brought to gage on the roughing mill, the strip is turned over after rolling in order to facilitate inspection and remove any slight remaining scale. It is then transferred to a leveler or straightener of extremely rugged construction. From this the product is delivered to the hot bed.

When producing lighter material only the roughing operations are used on the roughing mill, as a train of finishing mills has been provided for the final passes. These mills are operated entirely by mechanical means, no manual labor being required. Driving power is furnished by a Westinghouse motor of the Kramer type, permitting a wide range of operating speeds with good electrical efficiencies.

From these mills the material is delivered to hot bed or coiler, as may be required. On leaving the hot bed the strips are cut to length and piled by a mechanical piler, placed in stock if they are to be shipped as plain hot-rolled material, or transferred to the finishing department if additional treatment is required.

In addition to the usual slitting, shearing, oiling and lining machinery, the finishing department has extensive facilities for heat treating and pickling. Each

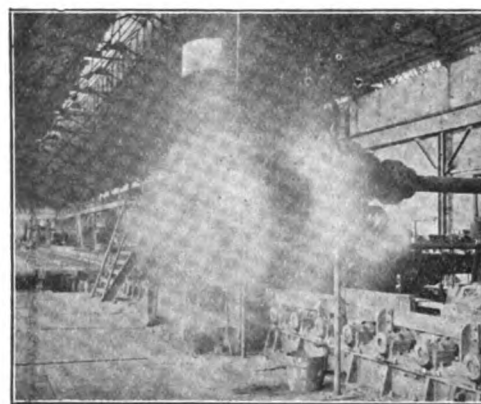
furnace has a charging capacity of approximately 25 tons and also the necessary mechanical means for reading and heat control, assuring uniform and proper heat treatment. The furnace men can observe and control the furnace temperature at all times, but the recording instruments and the records are seen only by the department superintendent, who thus has a definite and accurate record of all conditions and every operation employed on past work. The pickling vats are of the plunger type in standard details, but of large size for pickling large pieces, whether flat or coiled. The steam for heating pickle liquors and other miscellaneous heating process is generated by a boiler placed over the annealing furnace flues.

The research department continues further investigation through its physical and chemical testing laboratories. These laboratories provide to the inspection department all tests needed to insure thorough knowledge of materials produced, the extent of tests being dependent upon character, quality and ultimate use of material on order.

The National Pressed Steel plant has a number of unusual and interesting features:

- (a) Electricity used for power throughout.
- (b) Practical elimination of hard physical and hand labor which formerly has been the rule.
- (c) Large clean, well lighted and well ventilated buildings.
- (d) Extensive methods and extra care to eliminate scale.
- (e) Unusual heavy equipment to bring size variation to a minimum.
- (f) Unusual rolling methods to produce steels and alloys in steel of superior quality and new characteristics.

Experiments, investigation and research as continued by this organization will doubtless develop



Rolling Mill.

further data and information to enable production of materials with other new qualities and characteristics, and thus the field for specialties manufactured from such source of supply will be extensively broadened and developed.

Utilization of Basic Open Hearth Slag

Considerable Progress Made in England in Use of Basic Slag.
Efficacy of This By-Product Recognized by Foreign Authorities.
Experimental Work Being Carried On.

Some fifteen months ago Profs. Gilchrist and Louis drew attention to the urgent importance of utilizing for fertilizer purposes the vast quantities of open hearth basic slag which existed or were being produced in this country (this J., 1917, 261.) They pointed out that the neglect of this by-product of steel manufacture was due mainly to the circumstance that the availability of the phosphoric acid content was very low as compared with that of the basic slag obtained by the basic Bessemer process, when both were determined by the citric acid solubility test; that this test is a purely empirical and arbitrary one, having no direct relation to field conditions; and that the popularity of the test was to be ascribed to German business acumen, for Germany produced about seventeen times as much Bessemer slag and only about twice as much of open hearth slag as we did, and her steel manufacturers have been able to reap a rich harvest from the sale of this by-product.

In view of the commanding position which Bessemer slag had held hitherto, and of the fact that of the 25 firms which make basic slag in this country, only a few produce the open hearth variety, it was scarcely to be anticipated that any rapid headway would be made at the outset. Nevertheless we are pleased to be able to record that very considerable progress has been effected. A year ago the total production of ground basic slag, available for agriculture, was estimated at 400,000 tons for the period April, 1917-18. The actual quantity produced was about 25 per cent in excess of this estimate. The increase was due to the pressure exercised by the minister of munitions with the object of augmenting the quantity of low grade slag which was being ground. This satisfactory achievement was accomplished in spite of many difficulties, among which railway transport and the provision of the necessary facilities for grinding may be specially mentioned. Owing to the concerted action of the Food Production Department and of the Board of Agriculture no trouble has been encountered in getting the farmers to use this slag, and as the demand continues to be much in excess of the supply, there is little doubt that the further increased production forecasted for the coming year will be readily absorbed. In view of the enormous estimated annual production of open hearth slag, 750,000 tons or more, the above mentioned increase may not appear to be very great, but it must be borne in mind that much

of it is of far too low a grade to bear the costs of handling, milling and transportation, especially at the present time. Seven per cent total phosphoric acid is now regarded as the minimum payable grade, but in point of fact no slag containing less than 8 per cent is now being utilized. Moreover the production of open hearth basic steel in this country is continually on the increase.

That the authorities are convinced of the efficacy of open hearth slag is evidenced by the order issued on April 30 last (this J., 1918, 182 R). In the third schedule, which gives the maximum prices of ground basic slag, the grade is specified in terms of total phosphate, calculated as tri-basic phosphate of lime, and references to citric solubility are conspicuously absent.

Since the publication of the paper above referred to, G. S. Robertson (J. Bd. Agri., January, 1918), has adduced additional evidence in favor of the contention that low grade open hearth basic slag and also rock phosphate, when ground sufficiently finely, are valuable fertilizers for pasture land, and that their efficacy cannot be stated in terms of citric acid solubility. Prof. D. A. Gilchrist, who has done much of the pioneer work on the purely agricultural side, has recently undertaken a series of trials at Cockle Park to determine the relative values (on poor grass land and on soil sown with wild white clover) of high grade basic slag of high citric acid solubility and low grade basic slag of low citric acid solubility, and also the effect of grading up the latter by adding Tunisian phosphate to the contents of the open hearth furnace.

Practically all the experimental work done up to the present has been performed on grass land and the effect on arable land has yet to be ascertained. At the present time, however, this is not an urgent matter as there is an abundant and increasing supply of superphosphate, the use of which has been restricted to arable land. There is also scope for experimental trials to determine the relative value of low grade open hearth slag on different types of soil, for there is some evidence that it is more effective on the heavy soils of the north of England than on the lighter soils of the south. In view of the agricultural renaissance which is everywhere apparent in this country, there is little doubt that these investigations will be duly taken in hand; in the meantime the fact of outstanding importance is that serious and successful efforts have been made to utilize a by-product which was formerly relegated to the scrap heap.

An abstract taken from the Journal of the Society of Chemical Industry.

Principal Changes in Blast Furnace Lines

Bronze Cooling Plates Inserted in Brickwork—Development of Wider Hearths—Use of High Blast Temperatures—Discussion of Theoretical Lines and Prediction of Larger Furnace Capacities.

By J. G. WEST, JR.

General Blast Furnace Superintendent Jones & Laughlin Steel Co., Pittsburgh, Pa.

PART II.

With the returning of relatively lower blast volumes we find good tonnage, and longer lining records being made on thinner lines, with no cooling. A 31½-inch lining is still in use and has produced 506,000 tons of iron. There are also official records of linings, 36, 40½, 42 and 45-inch that have all produced above 500,000 tons of iron, and are still running.

In looking over the records of linings, we find that an unprotected wall of 52 inches at the mantle is used quite extensively. Very often in blowing out these linings are only weak at the stock line and the middle section. This type of furnace has produced most of the records made during the last few years on coke consumption, tonnages, etc.

From a study of the wornout lines there is no question that the thickness of brickwork could be reduced at different parts of the stack. This in itself means a labor saving, and idle time would be cut down when replacing.

Sketch No. 26 shows a type of lining that is thin towards the upper section, and has shown good practice.

When tearing out after making 670,000 tons of metal the brickwork was still in very fair shape. It can be noted also that this brickwork is butted direct against the shell so as to aid radiation or cooling effect. The large packing space between the brickwork and the steel shell may be one of custom, rather than need, as there are only a few shell failures out of the large number in use, and these failures occur chiefly on shells that are very old.

The added radiation introduced by having the brickwork butted against the shell should produce a longer life of the lining, and it becomes of no purpose to insulate the brickwork of the stack, owing to the fact that the internal chemical actions, etc., detrimental to the brickwork on the inside face of the lining, are retarded by cooling. Also, we have no refractory as yet that would stand up without being cooled on some surface. If this were before us, 40 inches of brickwork would last as long as the lining would do efficient work, owing to the fact that if the lines were to wear as large as the brickwork would

allow, the furnace would no doubt be giving considerable trouble.

It is problematical as to what tonnage should be gotten out of a lining, and the average of a series of campaigns is the best rule to use. We know that cases arise where the lining seems to be in good shape for an indefinite period, and others made from the same quality of material go quickly. At least 500,000 tons of good practice should be gotten out of the average 40-inch lining.

Manufacturers of refractories are making great efforts to produce good results, and it is hoped that their researches will lead to a combination of materials that will give longer wearing qualities. There have been some very fair records gotten during this last high production period, the average lining lasting as long as was ever done.

Metal Jacket Sprayed with Water.

This type of cooling is confined mostly to furnaces of relatively smaller sizes. It has been experimented with in the early days on furnaces of larger types and also tried on the thin lined blast furnaces.

In the furnaces of the magnetic ore regions it is still in use, but has not found favor in the larger type of furnaces used in the steel making plants. It did not work at all well on the thin lined furnaces and had to be abandoned, as no end of trouble was experienced in its operation.

3—The Bosh Section.

Below the mantle section there is a sudden change of the state of the materials, caused by the rapidly increasing temperature, the mixtures becoming soft, semi-liquid, and producing great pressure and wear.

These temperatures, etc., are sufficiently high, to cause a complete fluxing or melting of any refractories ordinarily used. Air cooling alone will not fill the requirements. This has been overcome through years of experimentation by introducing systems of water cooling, which have the effect of maintaining a balanced thickness of walls.

The inside surface early in the period becomes coated with a conglomeration which maintains a wearing surface that makes up or reduces in thickness, depending on the internal temperature of the furnace conditions.

Metal Jacket with a Few Cooling Plates Inserted.

This type can be sprayed with water when neces-

Final installment of paper read before May meeting of American Iron and Steel Institute.

sary. We find it in current use at plants using a percentage of foreign ores, and the comment from this locality is that its use will be continued.

Bronze Cooling Plates Inserted in the Brickwork.

This form of bosh protection is by far the most popular and its use has covered so many years that its durability is beyond question. It would be a very difficult matter to offer anything better in lasting qualities, strength and neatness of design, than this American type of bosh construction, and its life is quite a bit longer than any other part of the furnace lining. In some places it is not removed when replacing the upper wall of the lining. Its effect in keeping the balanced thickness of walls, and also offering a uniform smooth surface to internal conditions, has been proven to be a condition, that while not ideal from a thermal standpoint, is the best from a construction point of view.

The method of placing the cooling plates vary in different localities, there being differences between the rows, the number of rows, and the covering of the edge of the plates with brickwork.

At the same plants where the opportunity has been offered to judge the difference in the working of the furnace with and without brick in front of the coolers, there is strong indorsement in favor of covering up the edge of the coolers before starting.

The thickness of the brickwork using this method of cooling varies from $22\frac{1}{2}$ to $31\frac{1}{2}$ inches.

Bronze Plates and Cast Iron Boxes.

On account of the bronze being costly, and there being an idea that the plates as shown in sketches Nos. 29 and 30 required a longer time to remove, when necessary, a construction was developed as noted in sketches Nos. 31, 32, 33 and 34.

The cast iron boxes or receptacles hold the bronze plates. Air cooling was to aid in holding the lines. This would reduce the cost of the bronze considerably, but it would not make as tight a construction as was noted in sketches Nos. 29 and 30, there being great tendency to have minor troubles, which are liable to cause stoppage of the furnace. Also the inside surfaces are not held with as smooth a face as was experienced in the sketches before mentioned.

In sketch No. 34 is shown an effort to reduce the cooling with this type of construction, and with the result of a weakening of the walls, which were eaten away shortly after being blown in, as noted by sketch No. 35.

This coupled with bad distribution caused an undue amount of copper loss, the cast iron boxes becoming so warped that it would be necessary to drive the cooling plates inside the furnace, when they required changing. If perchance this construction happened to be used with a poorer grade of fuel, further trouble also developed.

In the plants that have had the opportunity to

compare all classes of bosh construction, sketches Nos. 29 and 30 are strongly favored, giving better working conditions, lasting longer and being a neater design.

Tuyere Section.

There is offered quite a bit of opportunity to vary the manner in strengthening the bosh at the tuyere section and it should be borne in mind that this area stands the most crucial actions of the furnace. Around this section there is the highest temperature that is attainable in the whole process. Any effort that is used to skimp on the cost of material around this section usually reflects back to the idle time a furnace may be off on account of minor breakouts.

Sketches Nos. 36, 37 and 38 will give some variations on the methods of strengthening this section of the furnace lines.

Rolled Steel Section.

The tuyere coolers are sometimes placed flush with the edge of the brickwork, and others are a few inches back at the start of the blowing in.

The common section of the tuyere cooler is usually as shown in sketch No. 39.

The number of tuyere openings at the modern plants vary from 10 to 12. The results obtained with 12 tuyeres are no better than those obtained with 10. There is not a great deal that can be said on this matter to give any conclusions. Sizes of tuyeres used, etc., belong to another discussion.

The outlet for cinder or slag does not show any wide variation in its distance from the tuyere area, and its protection is usually constructed of a cast iron body with water pipe inserts. Some places prefer to use a bronze cooler, but this does not give any better life and is more expensive. The height of the cinder notch above the tapping hole varies with the depth of the well or hearth, and is only noticeable on the design of the deep well furnace, there being some comment that the cinder notch can be too high above the tapping hole in order to give the best results.

Sketch No. 40 shows the iron coolers.

4—Hearth Section.

The hearth section is interesting in the fact that it varies in depth in the larger furnaces and in its protection.

In a type of large furnaces the hearth is made so that the iron is cast in six-hour periods. This holding is carried on without any serious damage. The larger the hearth, theoretically should give fewer stops and more tonnage, caused by the elimination of these stops. If the hearth is too large, there are opinions that it influences the kind and quality of iron that it is possible to make.

The brickwork walls of the hearth vary from $22\frac{1}{2}$ to 60 inches.

Sketches Nos. 41, 42 and 43 show more variations of this.

Owing to the static pressure-erosive actions of the metal cinder, there should be no tendency to slight any quantity of brickwork. The bottom of the hearth is commonly made of blocks of little larger size than the walls. There have been numerous methods tried to make tighter construction, by shaping the brick, etc., but there is no great claim that can be made for any of these.

The protection of hearths, known as cooling jackets, etc., are of many designs, and can be noted on sketches Nos. 44, 45, 46 and 47, which are the most commonly used.

In some plants we find what is known as a sub-jacket placed at a slightly lower level. The tight jackets are usually backed up with brick and cement. In spite of long years of study with the materials and workmanship, hearth trouble still occurs in the way of breakouts. These, however, are handled by so much easier methods than in the old days that they do not cause such bad losses as were formerly experienced.

Design of Complete Lines.

In looking over the drawings of the representative lines of 10 years ago, we would find that the average blast furnace of the steel making companies would be represented by sketch No. 48.

This type was one of the first to give consistent high production, and varying from this average design some were made with the boshes 23 feet in width, and there was a tendency to make the furnace taller, up to 105 feet.

The operation of these tall furnaces has given satisfaction in the places where used, but the design has not spread very widely.

Sketch No. 49 will show one of the lines of these tall furnaces.

A study of the work is shown in the following table:

Date	Plant	Furnace	Height	F. Car.	Aver. daily tonnage	Coke per ton of iron	Estimated hot bl. tem.
1917	1	"A"	99 ft.	90	500	1861	1100
1917	2	"A"	105 ft.	89	556	1945	1140
1917	2	"B"	105 ft.	88	553	2065	1030
1917	3	"A"	105 ft.	88	508	2064	890
1917	3	"B"	103 ft. 10 in.	88	486	2072	890

To get another view of the working of these tall furnace designs, would be to compare them with others in the same group of 90 to 95 feet high, and use as nearly as possible the same material, hot blast temperature, etc. Where such an opportunity has been offered, no great claims have been made for them. It is a safe conclusion that the added height of 10 to 15 feet has not been shown to be conducive to greater outputs, although the taller furnaces work very smoothly.

Sketch No. 50 will show the present lines of a large furnace of some of the larger steel plants, and it can be noted that there is a great difference in the section below the mantle.

Development of Wider Hearths.

Before the year of 1910 a change in the bosh lines was started, consisting of a shortening of the distance from the tuyere to the bosh line, and widening of the space from wall to wall at the tuyere coolers, thus straightening the angle of the bosh line. At this time a great deal of discussion was aroused over its possible success, as the theory of blast penetration was still held by many. It was a number of years before the large hearth was recognized, even though results were being accomplished that spoke for themselves.

In the exposition of this idea, the Chicago furnaces of the corporation had pioneered and advanced further than anyone, and their success was shown in their wonderful yearly record of over 2,000,000 tons on a coke consumption of well below 1,900 pounds per ton of metal.

In studying the situation, this development is the only radical one that has been generated in years, which in all cases where applied, has shown better productions, increased tonnages, lower fuel consumptions, and in the better use of hot blast temperatures, nearer to those that were used on different materials in the earlier years of American blast furnace practice. It appears to have advanced the progression of new development, using Mesabi ore, and the raw materials inferior in quality to those formerly used, and better results have been gotten in spite of a deterioration of the physical and chemical properties of our fuels.

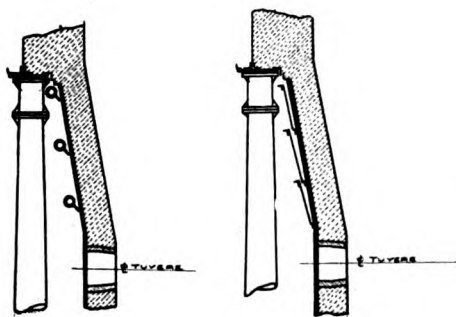
In furnace plants where these changes have taken place there have been some remarkable increases of tonnage, etc., in spite of the fact that the materials are the same, or maybe somewhat inferior to those used before the change.

Sketches Nos. 51, 52, 53, 54, 55 and 56 will show some dimensions of present furnaces, boshes and hearths.

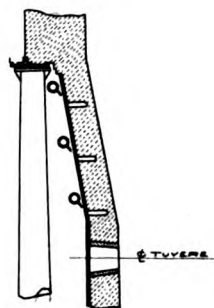
In a table compiled by the author there are shown a few representative plants taken from different sections of the country, and the results obtained after changing the hearth. In every case, without exception, there has been a decided improvement for better all-around work. This table will also show the various percentages of Mesabi, heats carried, etc. Detail information is lacking from a number of the plants. There has been a similar improvement made in using a wider hearth in small merchant furnaces.

In the making of the higher coke irons, such as ferro-silicon, ferro-manganese, etc., again has this wider hearth shown a decided improvement on pro-

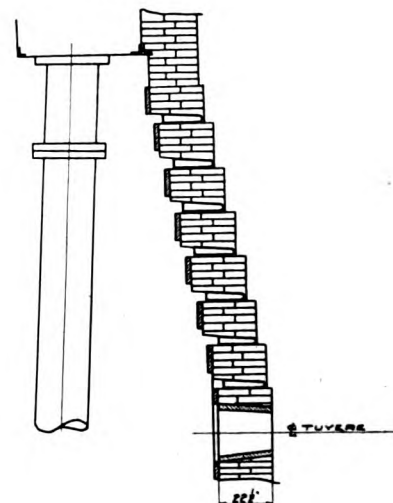
SKETCH N°27



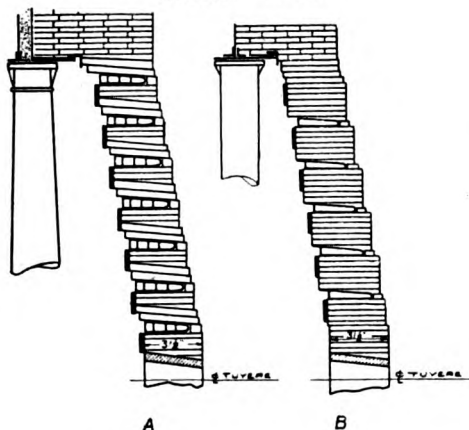
SKETCH N°28



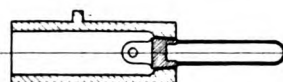
SKETCH N°29



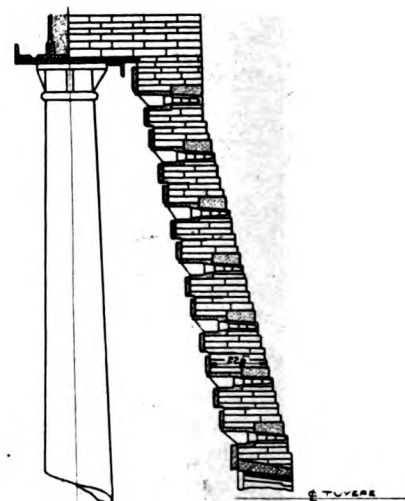
SKETCH N°30



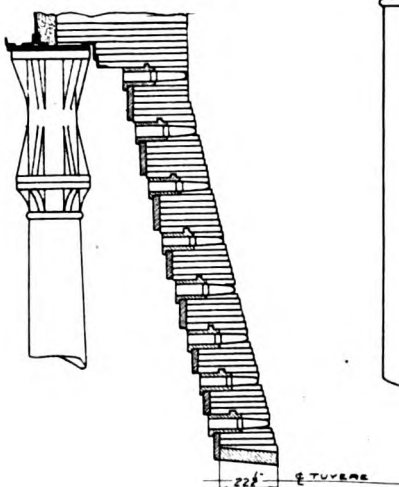
SKETCH N°31



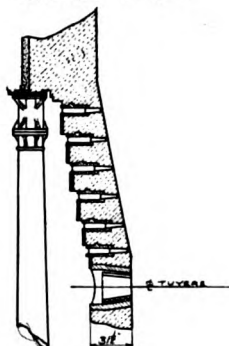
SKETCH N°33



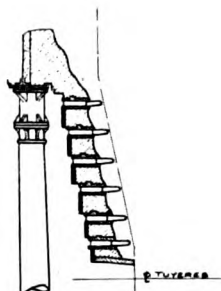
SKETCH N°32



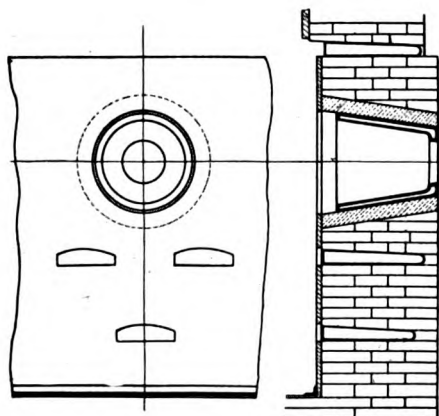
SKETCH N°34



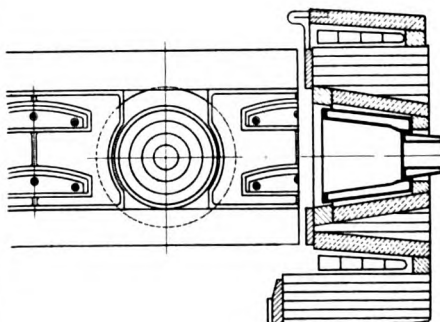
SKETCH N°35



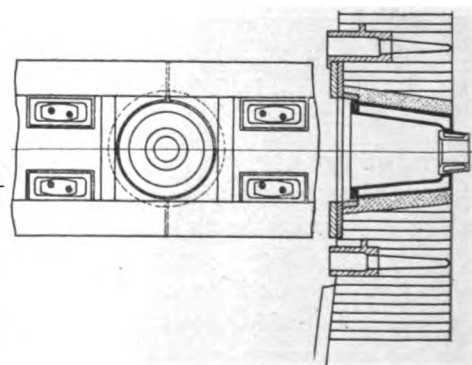
SKETCH N°36



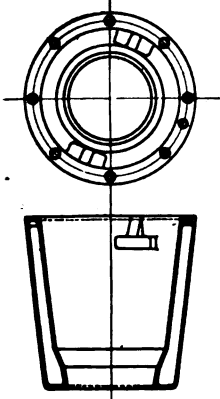
SKETCH N°37



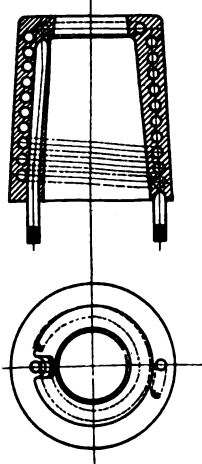
SKETCH N°38



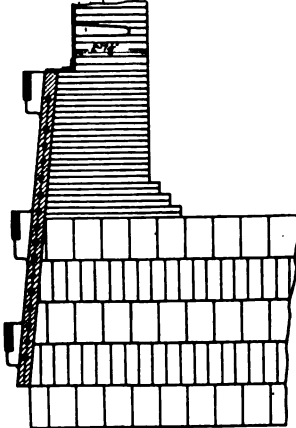
SKETCH №39



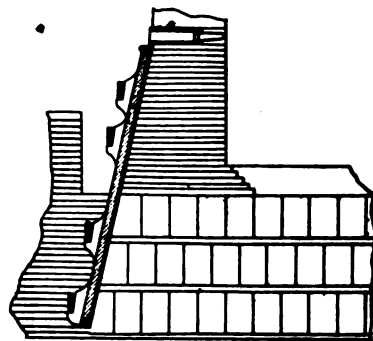
SKETCH №40



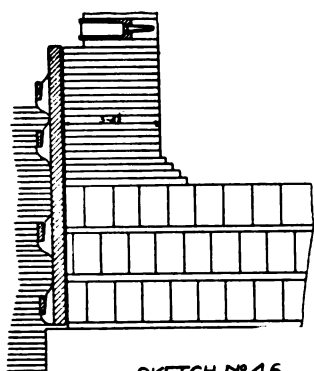
SKETCH №41



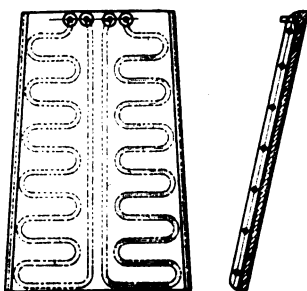
SKETCH №42



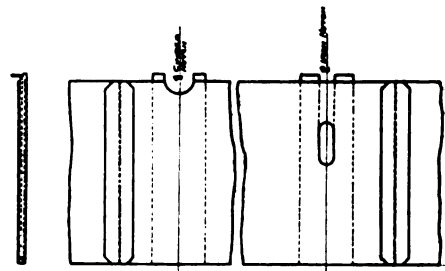
SKETCH №43



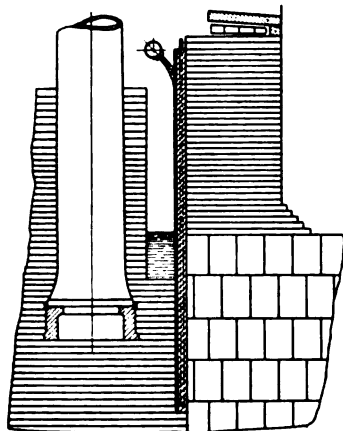
SKETCH №44



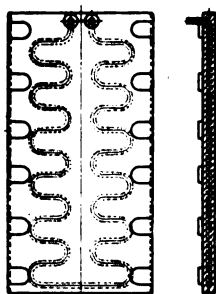
SKETCH №45



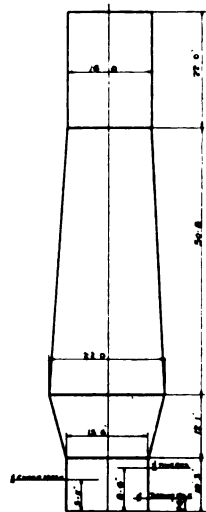
SKETCH №46



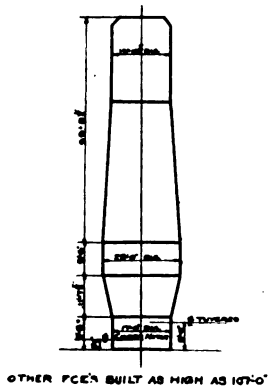
SKETCH №47



SKETCH №48

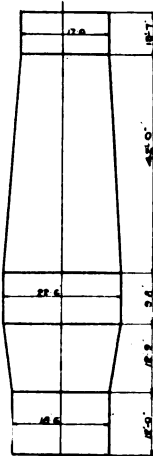


SKETCH №49
SK OF TALL FCE 1914

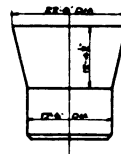


OTHER FCE'S BUILT AS HIGH AS 107'-0"

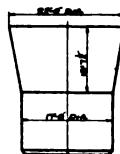
SKETCH №50



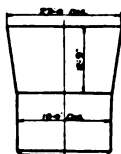
SK 51



SK 52



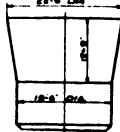
SK 53



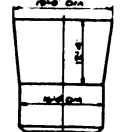
SK 54



SK 55



SK 56



duction, smoothness of operation and in lower fuel consumption. To those who have had the opportunity to watch these ideas there is no doubt that it is the largest step made in recent years to overcome the obstacles of increased tonnages, lower coke consumption, etc.

In the latter part of 1917, and the first part of 1918, a great many of the furnaces were subjected to the worst possible irregularities (fuel that had lain in the stock pile for years, slack blasts, etc.), yet their performance even on this inferior material was good, and now, coming out of this irregular period, they have gone back to their original good work.

It can be noted in the preceding table that some of the plants on which the furnaces were changed are working on inferior fuel, yet their results compare well with some of the others.

The batter of the upper walls and the angle of the bosh are subjects that no longer interest us, as much as the relation between the bosh diameter, the hearth diameter and the distance between these points, the angle of the bosh working out to these dimensions. This angle of the bosh is becoming so nearly vertical that its influence cannot be so serious a matter as it was in former designs.

The Using of High Blast Temperatures.

In the ability to carry higher blast temperatures, the average line of heat at the larger plants has risen to the 1,200 deg. F. line, and very often we hear of it being used above 1,200 deg. F. with a great deal less attending trouble than was experienced in the former years of blast temperature around 850 deg. F.

In using these higher hot blast temperatures on poorer grades of fuel it is found that close adjustment of the blast volume, with relation to the temperature, influences the smoothness of operations to a considerable extent.

For a furnace to use 1,200 deg. F. of blast temperature, the burden has to be delicately balanced; also in rising from this point to, say 1,300 deg. F., another adjustment has to be made. One could not hope to have smooth operations if adjustments are made quickly between such high points. It is a well known fact that a variation of 50 deg. in hot blast temperature, means sometimes good or bad furnace operations, and here the personality of the furnace operators influence somewhat the ability to carry such high temperatures.

The closest attention should be given at all times to the state of the furnace, with the idea of meeting charging conditions.

At places where irregularities do not occur with wide and sudden fluctuations, a close usage of the maximum blast temperatures is possible.

If the plant conditions and furnace operations permit, even with widely varying fuels, blast temperatures can be made to average within 5 per cent of the

total available. A large reserve is not necessary with close watching. There are a number of plants that operate for long periods of time, during which the wind variations are the only reserve. The utilization of these relatively high blast temperatures is limited in the majority of cases, even though Mesabi percentages may be above 85 per cent, by the ability to get such temperatures.

This possibility to carry high heats has enabled these plants with lower fixed carbon in their fuel to obtain very fair results, and also with Mesabi ores being carried beyond percentages that were anticipated only a few years ago. This is shown at a certain plant which made a plant run of 1,843 pounds of coke per ton of metal during the month of March, 1918.

In the matter of this hearth development there are several linings projected which have a 22-foot diameter of bosh, and a 19-foot 6-inch to 20-foot hearth. We also know of one development with a 19-foot bosh diameter, and a 16-foot hearth diameter, with hopes of a further bettering of all conditions.

There is some hesitancy, however, in the expression of opinion as to whether the extending of the hearth diameter from 18-foot to 19-foot 6-inch or larger has added anything for the betterment of all conditions.

Comment on the Use of Inferior Raw Materials.

In the last few years, at those plants where there has been no campaign to improve the coke quality, the general average of the quality of the fuel has deteriorated, the fixed carbon decreasing and the ash and sulphur increasing.

The large hearth furnaces show good workings under these adverse conditions. The sulphur elimination shows excellent temperature. Sulphur cannot be controlled unless the hearth temperature conditions are excellent. Cokes averaging as high as 1.30 per cent sulphur are being handled daily, on glassy slags, the iron produced meeting average mill basic and Bessemer specifications. This, however, is no attempt to endorse high sulphur in coke; it is easily figured that anything like this percentage reduces the output to quite an extent.

Theoretical Lines.

The ultimate blast furnace of 600, 650 and 700 tons' daily average over a period of a lining's life is just as much a conjecture as has been the development of the 550-ton furnace.

We find early English furnaces that were built 43,000 cubic feet capacity, and their results showed no conclusion.

There is no reason to think that the bosh or the hearth diameter has been carried too far. The percentage of influence that might be gotten by retarding the stock descent with an angle of approximately

83 deg. is small in comparison with the total cubic contents of the bosh.

The high points of production gotten lately at different plants (for instance, the Monessen furnace of the Pittsburgh Steel Company), are a source of very interesting study to the fraternity at large.

This plant has consistently produced very high tonnages over a period of years, and it would be for the good of the fraternity in general if we could hear of something from this practice.

In other places where the fuel has been given close attention, we find large outputs being attained on short runs. As a rule they have not been maintained for long periods, and these runs are at places that have produced a very high quality of fuel. One is inclined to believe the increase of production, etc., is to be advanced by a bettering of the fuel and other material.

The regulation of the blast furnace, for the amount of material used, is as close as any human machine, and as a rule the material given to the furnace operators is one that varies widely.

The physical properties of the fuel have an influence on consistent furnace development, owing to the fact that between the lining there may be a varying condition which upsets all study or calculation. If the fuel is soft, small and irregular, all efficiencies at hand cannot be used to the best advantages.

In obtaining some of the results of the last four or five years in coke practice and tonnages, there are plants which have worked continually under conditions of regulation, whereby for long periods at a time it would have been a difficult matter to have increased the burden more than 1 or 2 per cent, and this

when using material that in former years was condemned very severely.

The 1,000-ton furnace is not an idea that will be abandoned, but will be attained; whether along the present lines, or a complete revolution of designs, no one knows. Science has not been able to go any faster than practice has allowed.

There is no doubt that the temperatures within the furnace are sufficient to do all the work of reduction, etc. The time element necessary for reduction is stationary within certain limits. Where this time element is hastened through unusual, unpremeditated and uncontrollable conditions we find abnormal productions, efficiencies, etc., for short runs.

If, as in other lines of science, progression is by spurts, rather than by steady increase, then these points of high production, lower coke practice, etc., will come gradually closer together, and the average lines of results desired will be gradually raised.

Modern progression of metallurgy has been paralleled by better adaptations of the mechanical construction. Without the perfect mechanical construction a steady increased production would have been retarded. The simplest of details have been worked out to enable the lost time of the furnace operation to be reduced to a minimum figure.

In the operation of any design, etc., at a blast furnace plant, the personality of the operatives is one that reflects largely on the results attained, and these should be of the best type possible, owing to the fact that nowhere do we find so large a responsibility placed on as small a crew as we do around a modern blast furnace.

Copper Tuyeres for Blast Furnaces

Copper Tuyeres More Durable, More Quickly and Less Laboriously Removed and Replaced—Disadvantages of Cast Iron Tuyeres on Blast Furnace Units Removed.

By A. K. REESE.

The use of copper tuyeres in blast furnace operation is a phase of modern practice which has still a wide field for adoption in this country, as many furnace managers continue to use the old cast iron tuyere made by running cast iron around a coil of pipes bent to the desired shape. The copper tuyere consists of a hollow copper casting—or forging with cast copper, brass, or steel outer end—with walls from $\frac{3}{8}$ -inch to $\frac{1}{2}$ -inch thick, the cooling water being led to the nose or inner end of the tuyere by a thin brass tube attached to the inlet opening and extending to within about three inches of the nose, thus insuring a

good circulation of cold water through the portion of the tuyere which is subjected to the greatest heat. Fig. 1 shows a section through a cast copper tuyere, and the dot-dash lines at X mark the position of the brazed joint in making a forged copper tuyere of the same section.

The copper tuyere is usually used in conjunction with a copper cooler of somewhat similar shape and design to the tuyere. The cooler is set rigidly in the brickwork of the furnace wall, extending to its inner edge only, and is of such size that most of the tuyere passes through the cooler, the outer and larger portion of the tuyere making a joint about three inches long with a corresponding inner portion of the cooler. The

Paper read before annual meeting of British Iron and Steel Institute, May 2-3, 1918.

purpose of the cooler is to form a cooling protection for the brickwork about the tuyere arch, and to provide a rigid seat for holding the tuyere in place and keeping it at a fixed position in relation to the inner edge of the furnace wall and the center of the furnace, also to insure ease of removal and to do away with

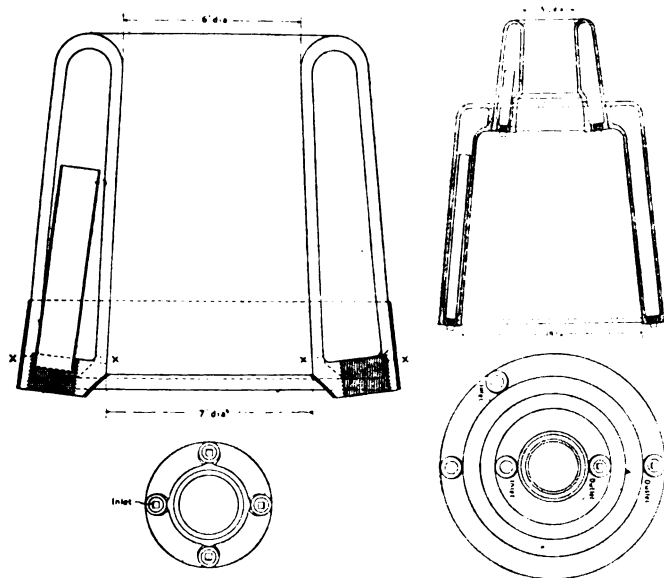


Fig. 1—Section through cast copper tuyere.

the use of the clay packing usually necessary where cast iron tuyeres are used. Fig. 2 shows the arrangement in section.

At first sight the equipping of a blast furnace with copper coolers and tuyeres seems to be an expensive arrangement compared with the old cast iron tuyere arrangement, and in first cost this is undoubtedly so, but in blast furnace construction first cost must not be given too great consideration if economical results are to be obtained, and there are certain advantageous features in connection with the use of copper tuyeres as compared with cast iron tuyeres which fully warrant the greater first cost.

First, they are much more durable, they are much more quickly and less laboriously removed and replaced, and they form a much neater and more mechanical job.

Secondly, there are certain serious disadvantages having an important bearing upon blast furnace results, arising out of the use of cast iron tuyeres, which are entirely removed by the use of copper tuyeres.

It is very important in a blast furnace designed for a certain diameter of hearth, that the extension of the tuyeres inside the furnace walls should be constant and the same for each tuyere. The diameter at the tuyeres, i. e., the distance from the nose of a tuyere on one side to the nose of the tuyere exactly opposite, is the real hearth diameter, as the horizontal area inside the tuyere noses represents the grate of the furnace, and the amount of fuel to be burned is in proportion to the cubic feet of blast blown per minute

and the area of the hearth or grate of the furnace. The furnace manager determines by experience, and perhaps by experiment, when necessary, the size of tuyere most suitable for any particular furnace conditions, this size depending upon the quantity and normal pressure of the blast, the number of tuyeres, and the extension of tuyeres inside the furnace walls, this extension varying, according to the conditions under which the furnace is being operated, from 6 to 15 inches. Having determined the most suitable extension of the tuyeres, that extension must be regularly maintained, otherwise the destruction of the furnace walls will take place through lack of sufficient penetration of the blast into the center of the furnace, or certain disturbances will occur dependent upon uneven blast distribution.

With cast iron tuyeres, when a tuyere burns or cracks and water runs into the furnace, the water must be turned off at once to avoid chilling the furnace hearth, and when the water is turned off the tuyere immediately melts away, and the furnace is run with the nose of that tuyere right back to the furnace wall. As it is not necessary to remove the tuyere at once, the water being turned off, there is also a tendency for the men or foreman to wait for a convenient time before taking the stub of the burnt tuyere out and replacing it with a new one with the proper extension. During this time the furnace is working lopsided, and a strong tendency to irregular working established.

With copper tuyeres no such haphazard practice

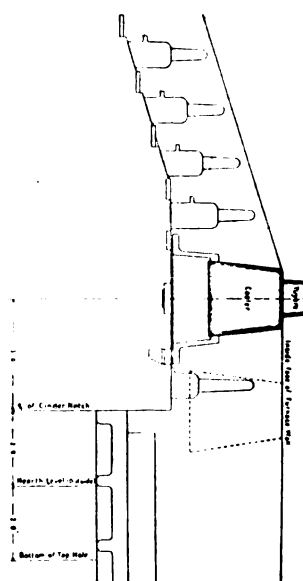
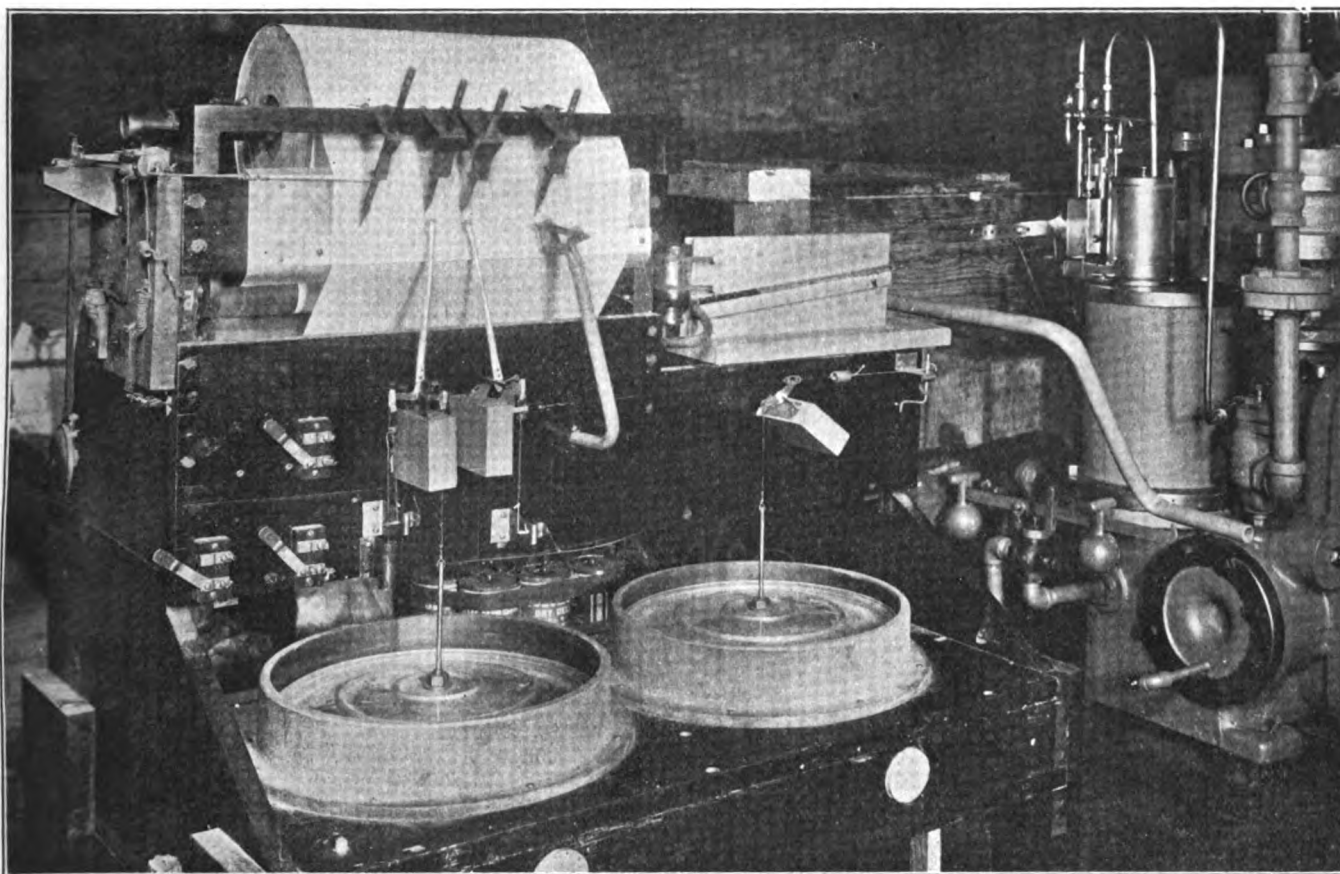


Fig. 2—Arrangement in section.

can be indulged in, for the water must be kept on the tuyere until the blast is taken off the furnace and the tuyere removed from the cooler, because if it were not the tuyere would burn back, the copper would be lost, and incandescent fuel would blow out through the burned tuyere. The copper tuyere must, therefore, either be taken out at once, or the water slacked down, to minimize the leak, until cinder is run out. The proper extension of the tuyere inside the furnace wall

is therefore maintained at all times. Until a few years previous to the outbreak of the war, copper tuyeres were always made of cast copper, and owing to the lack of homogeneity in such metal the life of these tuyeres in the furnace rarely exceeded a few months before cracks would occur in the nose through wearing away.



By-Product Coke Oven Pressure Regulation

Description of Regulator Employing the Use of a Bell for Primary Control of Light Weight Whose Travel Is Limited to a Few Thousandths of an Inch.

By CHARLES H. SMOOT,
Rateau Battu Smoot Company.

PART II.

We will describe in detail below a regulator which meets the coke oven requirements. The feature which makes it successful is the use of the bell for the primary control of light weight, whose travel is limited to but a few thousandths of an inch and therefore capable of responding within a small fraction of a second and taking new positions for slight changes in pressure.

Directly connected to the bell is an unbalanced steam valve so arranged that in steam pressures are reproduced the variations in gas pressure, but multiplied by several hundred, so that the unit steam pressure varies several hundred millimeters of water when the unit gas pressure varies one millimeter of water, the multiplication of unit pressures being determined by the relative piston areas of the bell subject to gas pressure and of the valve subject to steam pressure, the total forces exerted by the gas on the bell being **equal and opposite in effect to the total forces exerted**

on the steam valve, the system of bell and valve being freely floated on the impressed fluid pressures.

The multiplied gas pressure in steam is then caused to act in a steam cylinder of liberal proportions and develop there sufficient force for regulating purposes. Also liberal travel can be allowed to the steam piston without handicap of inertia.

This regulator can be operated on steam, compressed air or water, with a minimum pressure of 30 pounds.

In Fig. 3 is shown a simplified diagrammatic line drawing of a gas regulator of this type. It differs only from the actual apparatus in that the relay steam control cylinder which supplies a large amount of energy to overcome the frictional resistance in the gas valve is omitted.

In Fig. 3, A is the gas main from retorts to regulator. B is a small bell receiving the gas pressure underneath. C is a counterweight attached to a lever

which serves to adjust the pressure maintained in the gas main A. Direct connected to the bell is a small unbalanced valve D, which floats on escaping steam issuing from the orifice at the top of the metering cylinder E. The steam pressure maintained within the cylinder E when supplemented by the gas pressure under the bell B is sufficient to keep the floating valve D off its seat a small amount, and by varying its lift automatically maintains a constant pressure in the cylinder E when the gas pressure is constant, but

small orifice which limits the flow to any amount desired.

Within the cylinder E is a piston G, which has on top the steam pressure of the metering cylinder E and underneath the pressure of atmosphere supplemented by a lifting spring.

The motion of the piston G is controlled by the atmospheric pressure and spring on the one hand,

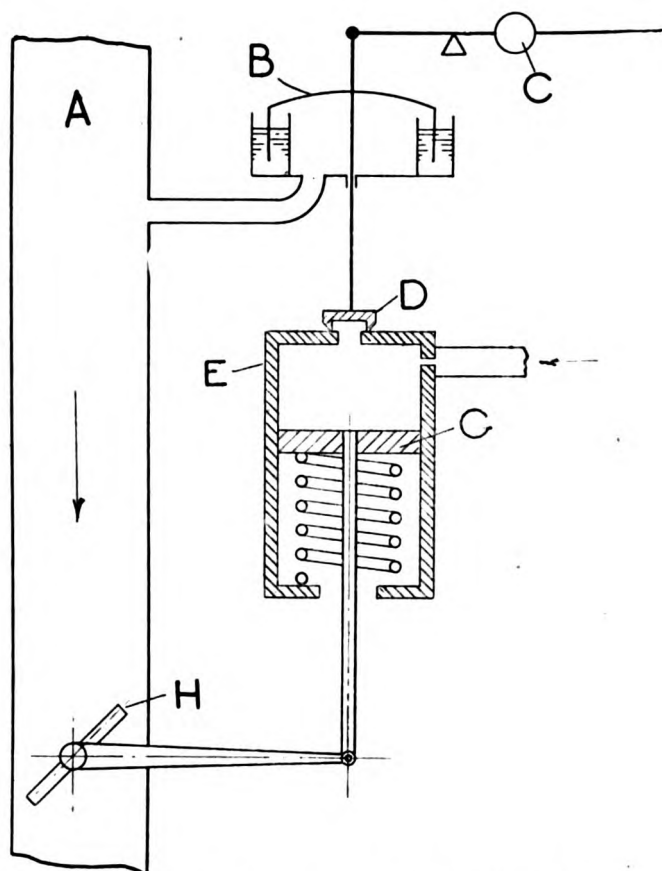


Fig. 3—Simplified diagrammatic line drawing of a gas regulator.

if the gas pressure changes then the force exerted on the bell B changes and the valve D takes a new position of such a character that the steam pressure on valve D changes to compensate for the change in force on bell B.

Since the valve D is very much smaller in area than the bell B, the changes in steam pressure within the cylinder E are equal to changes of gas pressure on bell B, but multiplied by the ratio of bell area to valve area.

In the actual apparatus this ratio of multiplication is 175, so that a change of one millimeter in gas pressure on the bell produces a 175 millimeter change in steam pressure on the valve D.

F is a pipe line which supplies a small amount of steam flow continuously to cylinder E through a

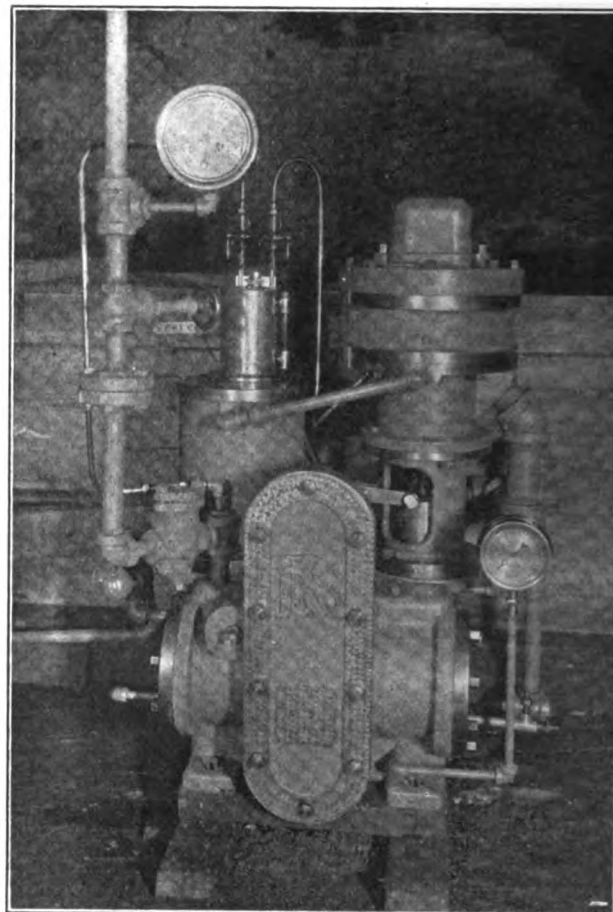


Fig. 4—Illustration of regulator.

and the steam pressure as regulated by valve D on the other hand.

The gas regulating valve H, which controls the pressure in the gas main, receives its motion from the piston G.

When the gas pressure rises under the bell B, the valve D is lifted slightly off its seat, the steam pressure in cylinder E is reduced, the piston G rises and opens the valve H, allowing more gas to escape to the exhausters and reduces the pressure within the pipe A to the valve determined by the counterweight C on the bell B. A falling gas pressure gives the reverse action.

In actual application one millimeter of gas pressure produces one-ninth of a pound impulse on the bell B, and through the multiplying action of bell B and valve D produces approximately nine pounds of

effort on the piston G. This nine pounds of effort is then communicated to a pilot valve, which controls the motion of a liberal steam cylinder directly connected to the valve H.

First, this regulator takes the minute gas pressure and multiplies it into a much larger steam pressure. Second, the multiplied pressure is impressed on a metering cylinder and develops considerable force and travel. Third, the motion of the metering piston oper-

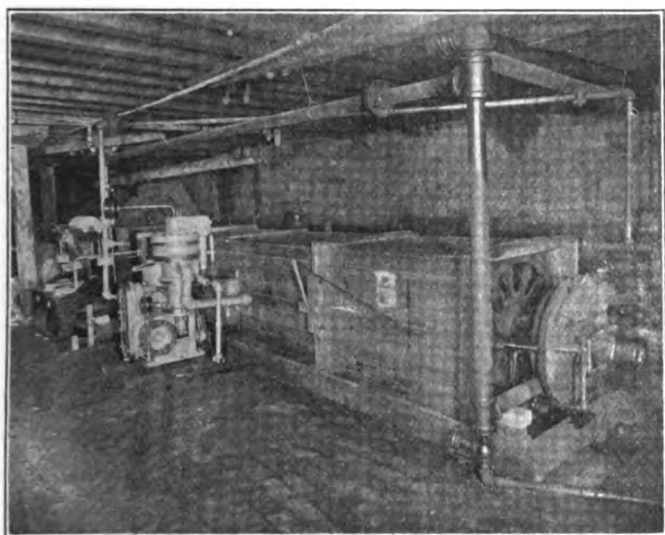


Fig. 5—Regulator installed.

ates a pilot valve controlling a powerful steam piston of ample energy to operate the gas valve.

By the use of steam in this regulator a number of difficulties incident to the gas regulating problem are readily solved. The immediate multiplication of the gas pressure into large steam pressures gives powerful forces for acting on the regulator, so that abnormal friction or mechanical derangement of the apparatus is not liable to interfere with its regulation.

The steam admitted to the machine excludes the entry of gas entirely from the regulator, so that no opportunity is presented for a collection of tar or other foreign substances which might interfere with its proper operation.

The apparatus is entirely mechanical and all parts can be made of heavy mechanical construction, strong enough to be safe from injury and enclosed, where they are not exposed to accidental derangement.

No difficulty is encountered in obtaining ample force to move the heavy gas valve, even though it may be clogged with tar, the steam supplying sufficient energy to the moving apparatus, so that the valve may be moved very slowly or very rapidly, as the change of condition may require.

The regulator responds to a one-tenth millimeter pressure, regulates within half a millimeter and is capable of more rapid motion than the maximum needful in a coke oven plant.

The motion of the gas valve has a speed of travel

in proportion to the extent of gas pressure departure from normal, a one-tenth millimeter change giving a slow motion and a half millimeter change a rapid motion.

Fig. 4 is a photograph of the regulator.

Fig. 5 and the illustration above the headline are photographs of the equipment as now installed in New York for test purposes, and this equipment is freely offered to by-product coke oven operators who may be interested in the apparatus.

Fig. 7 shows to the right a diagrammatic outline of the various parts of the regulator, which, as will be noted, comprise a bell, an unbalanced steam control valve, a metering piston acted on one hand by a coiled spring and atmospheric pressure; and on the other by steam pressure, which contains the multiplied variations in gas pressure. The motion of the metering piston is communicated to a pilot valve which controls the motion of a large steam piston receiving steam at boiler pressure and operates the control valve in the gas line.

The steam exhausted by the operating piston is stored and washed in a small reservoir containing water, where the pressure of the exhaust is equalized and held in reserve in order to supply a small amount of steam to the metering cylinder. The water and occasional surplus of steam are discharged through a simple weight-loaded relief valve, which acts to maintain more or less constant the water level in the reservoir and prevent very rapid changes of steam pressure. The water in this reservoir serves a double purpose, for in addition to equalizing the pressure and storing the steam, it also cleanses the steam of impurities which may be present, due to solid matter in the feed-water of the boiler plant, and allows such impurities to be carried off through the overflow. To prevent dirt entering the metering cylinder the steam on its way from reservoir to cylinder also passes through a small coke filter, which prevents any splash from the water entering the metering cylinder.

The machine is not affected by changes in steam pressure, which may go from 30 to 200 pounds.

This regulator has been set up in connection with valves and turbo blowers to comprise a complete testing equipment (illustrated in Fig. 5), in which the volume of gas to be handled by the regulator can be varied at will, as well as the pressures and volumes of gas, and gives a rather more complete method of testing a regulator than can be obtained when installed in a by-product coke oven plant; for in this latter case the volume of gas to be handled cannot be made to vary rapidly or slowly at will and must be taken as generated by the retorts.

To the lower left of Fig. 7 is shown a duct corresponding to the coke oven gas main, at either end of which are turbo blowers and two damper valves, one of which is arranged for hand variation of the volume

of air passing through the duct. The left-hand valve is connected to the regulator, which places it in such position as to automatically maintain the pressure between the two valves at the valve for which the regulator is adjusted.

The right-hand turbo blower in this equipment delivers a volume of air as desired under control of the hand-operated damper valve and replaces the supply of gas coming from the retorts in the by-product plant.

The left-hand blower creates a suction on the dis-

charges of record.

Second, a curve is drawn of the regulated pressure, showing the effectiveness of the pressure regulation.

Third, a curve is drawn of the suction at the discharge side of regulated valve.

Fourth, the motion of the regulating valve is reproduced on a curve, so that simultaneous records are made of regulated pressure, suction corresponding to the **exhauster suction** and control valve opening. In the upper left-hand part of Fig. 1 is shown this

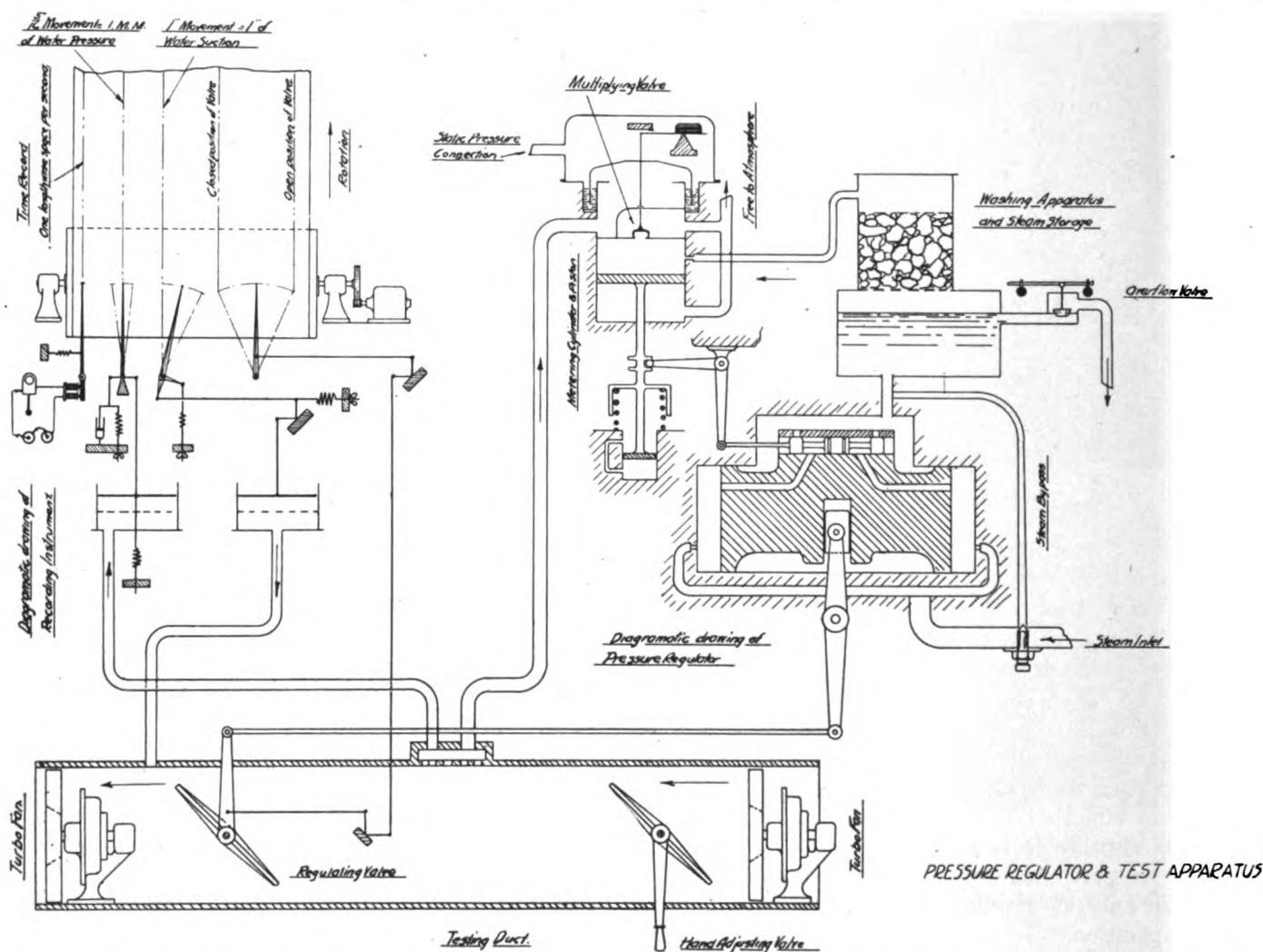


Fig. 7 shows to the right a diagrammatic outline of the various parts of the regulator, which, as will be noted, comprise a bell, an unbalanced steam control valve, a metering piston acted on one hand by a coiled spring and atmospheric pressure, and on the other by steam pressure which contains the multiplied variations in gas pressure. The motion of the metering piston is communicated to a pilot valve which controls the motion of a large steam piston receiving steam at boiler pressure and operates the control valve in the gas line.

charge side of the left-hand valve and replaces any action of the exhauster on the by-product plant, thus with this equipment we reproduce the several elements bearing on the regulator of the coke oven equipment and by these means can come to full range of action of the regulator.

A special curve-drawing gage has also been installed (illustrated in Fig. 6) with equipment which makes a graphic record, first, of the time in second intervals which by varying the driving motor speed can occur at intervals as close as $\frac{1}{8}$ -inch or up to several

meter in diagram.

The pressure records are made by a spark coil which perforates the paper in line with the pointer of the recording pressure needle.

It is possible to cause the regulator valve to make full travel in two or three seconds, or to give it as much slower opening as may be desired, by operating the hand control damper in series with the regulating valve.

Fig. 8 shows on a much reduced scale a typical record obtained by the above apparatus and it can be

seen on this record that the regulator maintained the pressure constant within variation of less than half a millimeter of water until the rapidity of opening and closing of the valve became very great, at which time greater departures from normal are indicated, and these departures are in a general way in proportion to the velocity of regulating valve displacement.

It should be noticed that even the slowest change in valve position shown on this record is far more rapid than the average rate of change needed for by-product coke oven regulation, the more rapid valve displacement being shown simply to illustrate that this type of regulator is both sensitive and rapid in its operation. It has also been observed that the regulator is exceedingly stable and when set for a maximum degree of sensitiveness shows no tendency whatever to continued racing or over-travel. A change of condition, such as an increase in volume of gas, is represented by a single sweep of the regulating valve, without over-travel and subsequent oscillations which

chines do not give a perfectly uniform steady blast of pressure, but because of their impact action produce a pressure which has very rapid vibrations in pressure superposed on the average blast produced. These vibrations have a tendency to widen the pressure line drawn on the record and appear at all points of the test duct, being very pronounced at the discharge end beyond the regulating valve.

The regulator described above involves a novel principle of pressure control, which has been developed and is now in use for the control of turbo blowers of both constant volume and constant pressure type, as well as for the speed control and constant speed turbine-driven electrical apparatus.

The original application of this type of regulator to the turbine blower gave with simple and dependable apparatus a pressure regulation which was astonishingly accurate and sensitive, its performance being so satisfactory that it was later applied to replace the centrifugal fly-ball type of governor on turbo genera-

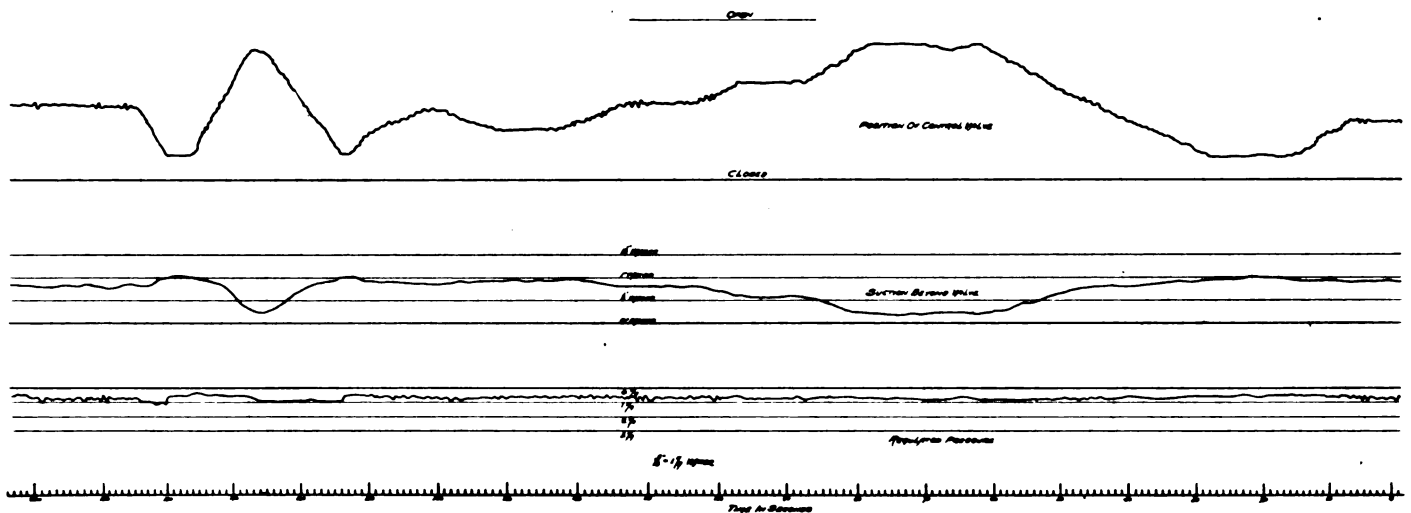


Fig. 8—A typical record made by the regulator shown on a much reduced scale.

are indicative of instability. This is shown in Fig. 8, where no over-travel of the valve occurred even after very rapid motion.

In order to serve as a continued check on the pressure recording equipment, a 10 to 1 inclined draft gage has been found most dependable and is connected to the test apparatus, where its action may be observed.

On these low pressures, however, the inertia of the water column in such an apparatus is so great as to make it of small value in detecting other than very slow changes in pressure. By changing the load very slowly, however, on the equipment, it has been noted that an opening and closing action is obtained from the regulator when the gas pressure is caused to depart one-tenth of a millimeter from its normal value.

The small vibrations shown in both pressure lines do not result from the regulator and are due to the instability of the turbo blowers supplying the flow of air through the duct under regulation. These ma-

tors and with excellent results.

This led to its development for the gas regulation problem and the same general principle is now being applied to a wide number of regulation problems, including steam pressure control and gas pressure control for public service corporations, and is worked out for constant pressure of delivery as well as an increasing pressure of delivery for increasing volumes, the pressure increase being in proportion to the square of the volume and therefore of the proper amount to compensate for pipe friction and deliver at the end of a long pipe line a constant pressure regardless of the volume flowing through the pipe.

This type of regulator is also available for numerous chemical operations in which several fluids are to be mixed in definite proportions of volume, but in varying total amounts. In the majority of regulating applications, including public service gas regulation apparatus, the gas pressure alone is used in the regulator and supplies the motive energy for its operation

Operation of Motor-Driven Continuous Mills

Description of Continuous Mill With Operating Data—Figures
Giving Power Consumption Per Ton, Including Auxiliary
Motors — Difficulties Encountered in Control Corrected.

By H. C. CRONK.

In submitting this article it is intended to give only operating features, theoretical and engineering features given only as a means of illustration.

The mills are of the Morgan Construction Company type, consisting of a four stand 21-inch section and a six stand 18-inch section, the 18-inch section being equipped with two 16-inch vertical edging stands, one located ahead of the first stand, and the other between the second and third stands and driven from the first and second stand pinions.

The mill is driven by a 6,000-hp input 5,750-hp output, 6,600-volt, 3-phase, 25-cycle, 92½ r. p. m. full-load speed, induction motor, directly connected to the mill shaft by an 8¾-inch by 9-foot 8-inch breakable spindle. As the motor is located between the two mills, the connections are so arranged that one connects to either end of the rotor shaft. By this method a breakable end thrust is unnecessary as is usually the case when the entire power is delivered from one end of the shaft.

The mills are capable of rolling billets 5 by 5-inch to 4 by 4-inch on the 21-inch end, and 1½ by 1½-inch to 3 by 3-inch on the 18-inch end, and sheet bar down to ¼-inch at the rate of about 115 tons per hour at its maximum capacity. The rolls used on the 21-inch mill are 23 to 22½-inch in diameter by 48-inch between housings and have necks 14-inch diameter by 17½-inch long.

The 18-inch mill rolls for billets are 18.45-inch diameter and 27-inch long, and for sheet bar are 18.50-inch to 17.92-inch diameter, 20-inch long, all having necks 12-inch diameter by 15-inch long.

Two methods of rolling are available; first, the 21-inch mill can be employed as a unit; second, the 21-inch and the 18-inch mill can be used jointly.

The 21-inch mill is fed from the 40-inch blooming mill direct, there being no reheating between the two mills, and the product rolled in it, can, if desired, after running out upon a 160-foot skew connecting table, be transferred by a drag type transfer across the mill about 30 feet upon a roller table which conveys it to the shears or hot saws as required.

The other method is the joint use of the two mills, the 21-inch delivering as above mentioned upon a 160-foot skew connecting table, but instead of the drag transfer taking the product, it is delivered to the 18-inch mill. After the required rolling on this mill, it

is delivered upon a roller delivery table through a Morgan flying shear which cuts the product into required lengths, passing on through the piling rolls to the bar piler, or to the skew piling table as required, finally reaching the cooling beds, where it is stored or loaded for shipment as demanded.

Preceding the 18-inch mills is a preliminary shear of the guillotine type with a swinging head, driven directly from the first stand driving shaft through a slip friction gear; the purpose of the shear is to cut any bad ends that may happen to exist on the piece coming from the 21-inch mill or to cut the piece as it is passing through the 18-inch mill in case a stand should cobble, which naturally lessens the scrap due to cobbling, as well as reduces the time required in clearing the mills.

The vertical edging stands are used on sheet bar only, being removed entirely by a crane when the mills are producing billets. The delivery and run-out table to and from the flying shear is driven from the main mill drive through change gears to insure the proper relative speed between the shear and the last stand of the mill.

The shear cuts the pieces into the required lengths, usually 30 feet, as they leave the mill while traveling at the mill speed. A feature of this shear is that it is entirely mechanically operated, having no electrically operated pilot which was so troublesome in the older models.

Except on rare occasions all stands are used on the 21-inch mills, but the number of stands in use on the 18-inch mills vary in accordance with the product; for instance, all stands would be working if ¼-inch sheet bar were being rolled, but with the maximum thickness 1½-inch sheet bar, only two stands would be required, two edging passes being in use for the minimum thickness and one edging pass for the maximum thickness.

When rolling billets 1½ by 1½-inch there is in use practically the same number of stands as when rolling minimum thickness sheet bar and only two stands for the maximum size 3 by 3-inch billets, the edging stands as stated above having been removed when the mills are changed over to billets.

The maximum time necessary to change the entire mill from one product to another is six hours. This small amount of time is due to the fact that duplicate housings are completely set up on the floor before the contemplated change is made. By this method it

Paper read before Cleveland section. A. I. S. E. E.

is only necessary to remove stand, or housings containing old rolls, and replace it with another stand containing the new rolls, guides, etc.

When rolling the minimum sizes of either sheet bar or billets on the 18-inch mill, the difference in elongation between the roll stands must be taken care of. This is best done by a loop in the metal; this loop is of semi-circular shape extending upward from the roll-center line. In order to start this loop, hydraulically-operated fingers are located between the roll stands, known as loopers, which throw the bar passing this point upward and the loop forms a radius depending upon the reduction. •

The motor and control are housed in a steel-and-brick building one-half of which extends as a shed into the mill building, the other half forming a lean-to on the outside of the main building. The part inside the building has a removable roof which gives access to overhead cranes. The power is transmitted from a sub-station some 350 feet distant by two 500,000-cm, three-conductor, 10,000-volt lead-covered cables which operate in parallel, a set of disconnecting switches being provided on either end of the lines. The 500,000-cm cables are each of sufficient capacity to operate the motor at approximately 75 per cent of full-load and either one can be entirely isolated in case of trouble. The sub-station end has a feeder switch, before the disconnecting switches, which acts as a feeder and is used as a means of governing the motor in accordance with the electrical requirements, the motor end of the cable after passing the disconnecting switches in the basement, continue on to the direction oil switches, one for each direction, then on to the motor primary. The secondary leads are carried to the secondary panel which in turn is connected to the resistance for acceleration. The direction oil switches, secondary panel and resistance are located on the motor room floor above where the lines enter the basement of the building from the underground conduits.

A primary control panel is also located upon the motor room floor, carrying control buttons for the direction oil switches, relays, transformers, instruments, etc. The master controller for accelerating purposes, together with an auxiliary primary control board, is located on the continuous mill pulpit, some 90 feet distant, from which point the operators of this pulpit handle the motor. No provision is made at this point for reversal as it has been deemed advisable to do this from the motor room only, by an electrical department representative.

The primary control panel in the motor room is equipped with, in addition to the appliances above mentioned, a voltmeter, a graphic watt-hour meter and a horsepower indicator. The horsepower indicator has been found to be much better than a watt-

meter, since anyone connected with the mill, particularly the rollers, can see at all times just how much work in horsepower they are doing; the horsepower being familiar to them, where the kilowatt is Greek.

As the motor operates somewhat intermittently and as it forms a large percentage of the power plant load, it is imperative that it be operated strictly in conjunction with the power station; therefore, when the motor is stopped for longer than 1½ minutes and no signal is given from the mill, the sub-station operator opens the oil switch and notifies the power station that the motor is to be down indefinitely. If, however, he has been given a time by the mill, he tells the power station operator the time, after this the oil switch in the sub-station will not be closed until the mill advises the sub-station operator that they want to start rolling, who in turn advises the power station operator and is given an O. K. by him; after this the sub-station switch is closed and the pulpit operator starts the motor, having been notified that the sub-station oil switch has been closed, by the burning of a red lamp in his pulpit.

The heaviest pull on the motor is during the period of light rolling, ¼ by 8-inch sheet bar causing the heaviest, at which time peaks of 5,000 kw or approximately 6,700 hp with all stands on both mills full while the load goes down as low as 2,000 kw or 2,800 hp. when rolling the maximum size 1½ by 8-inch bars. With billets 1½ by 1½-inch under similar conditions as the light sheet bar, the peaks are not higher than 3,500 kw, or approximately 4,700 hp and drop down as low as 2,500 kw, or approximately 3,480 hp when rolling the maximum 3 by 3-inch.

A representative power consumption is given below which incorporates three months of the last year:

Month	Tonnage	Total K.W.H.	K.W.H. per ton
October	20,000	480,000	24
November	23,000	483,000	21
December	1,800	432,000	24

These figures show that when rolling an average tonnage of 20,333 tons per month, that about 23 kw hours per ton are required. These figures represent all power consumed in rolling, including the auxiliary as well as the main driving motor, but exclusive of lighting.

Since the load builds up step by step as the piece enters one stand after another, no notching-back features are required to insert resistance in the secondary as the peaks come rather gradual and also because the power station has ample capacity to handle almost any load. It has been stated herein that the motor was coupled to the mill by an 8¾-inch breakable spindle, but to date not one of these spindles have been broken, although there have been loads imposed upon the motor of from 10,000 hp to 18,000 hp on several different occasions when pieces have been stuck in

the mill and had to be backed out or rolled on through the mills.

The auxiliaries used in connection with these mills are of the usual character used with these types of mills, the table feeding the 21-inch, and the connecting table between the two mills are each driven by a 40-hp motor controlled magnetically by a master switch. The skew assembling table which runs constantly when rolling billets, is driven by a shunt-wound 75-hp motor controlled magnetically by a master switch. The two straight edges and go-devils are each driven by a 75-hp motor, all controlled magnetically from selective type master controllers. The piling roll, however, is the most vital auxiliary in connection with the mill, as it must, when rolling sheet bar, keep the product which is coming in a continuous stream, away from the mill after leaving the flying shear.

This roll consists of a housing containing two rolls; the top one being driven by friction and loaded by spring to exert pressure enough on the bar when it enters the rolls to pull it through and throw it into the piling cradle setting from $4\frac{1}{2}$ to 6 feet distant, depending on the size being rolled.

It is, therefore, imperative that this roll run at a uniform speed, which is governed by the shunt field and must be a compromise between two conditions; first, it must take the product away at a velocity considerably in excess of the mill delivery speed; and second, it must pile the bar properly without damage to the ends from striking the cradle stop too hard and

not too much irregularity from not striking it hard enough. To assist in the proper piling, an adjustment of the piling roll bodily is provided; that is, it can be shifted nearer to or farther from the cradle, so that the bars may be properly piled after the motor speed has been determined which will keep the mill clear.

This motor was originally equipped with magnetic control with lockout accelerating switches and incorporated a shunt field relay. This type of control proved very unsatisfactory although not all trouble experienced was due to the control, the method of power distribution caused considerable trouble as well. We found, however, that the control could cause trouble and delay by some small part not functioning, usually due to lack of proper care and also because the operator sometimes threw the master switch off and in a few seconds decided to throw it on again before the motor had slowed materially. This resulted in the accelerating switches not closing and when a piece entered the rolls the motor would slow down, allowing pieces following to catch up; consequently a cobble on the mill. The failure of power acted upon the motor in the same way, and until we separated the blooming mill feeds from the continuous mills this gave us more trouble than any other one thing. It was finally decided, however, to try a manual rheostat with a separate field control which proved so successful that finally it is the type of control used on the motor. This, together with the change in the distribution system, eliminated the trouble which at times was extremely serious.

Problems of Steam Cylinder Lubrication

**Lubrication Difficulties Considered to Meet Existing Conditions.
Features Influencing Method of Lubrication, Such as the Cylinder,
the Valves, the Steam Flow and Steam Expansion Considered.**

By W. F. OSBORNE.

Writing in "Lubrication" the author brings out some interesting features concerning lubrication which are brought out in this article.

In 1914 the United States Census Bureau reported a total of 137,176 steam engines operating in the United States having a total rated horsepower of 15,681,688. Since that time the number of steam engines in use has been considerably increased, with a correspondingly increased demand for steam cylinder oils. As lubricating oils for steam cylinders are almost exclusively petroleum products, this increased demand has fallen on the petroleum industry, and while the production of petroleum has been greatly intensified, it is nevertheless quite necessary that all oils be conserved as much as possible to meet the requirements of the war industries of the United States and her Allies.

Steam cylinder oils may be conserved by the engineer through the application of scientific principles to the selection and use of the oil most suitable for each case. With the possible exception of internal combustion engines, the steam engine is the most familiar form of power producing machinery, and the short discussion of the principles involved will, perhaps, be of some interest and assistance to operating and designing engineers.

The sliding of the piston and piston rings over the internal surface of the cylinder wall creates a certain amount of friction, which, if not reduced by the use of some lubricating substance, will cause the loss of a considerable amount of power, and at the same time, will rapidly wear out the cylinder, piston and rings. It is therefore necessary to form a lubricating

film on the cylinder walls and the rubbing portion of the piston and piston rings, which will prevent this excessive friction. Practically all forms of steam engines, steam pumps and steam cylinder-operated apparatus are equipped with valves for controlling the action of the steam, and the majority of these devices also require lubrication to prevent wear and to reduce friction.

The loss of power caused by an improperly lubricated cylinder can be shown very readily on the indicator card by fixing all other conditions of operation and varying only the degree of cylinder lubrication. A poorly lubricated cylinder will quickly show on the card through increased i. h. p. or card area, and this increased steam consumption, of course, entails a greater coal consumption.

An English authority has estimated that if all the poor grades of oils in use were replaced with good oils, a saving of 15 per cent could be made in the amount of coal used for power purposes. This seems like a big figure but it should be understood that this excessive loss is not due to the actual difference in the co-efficient of friction of good and poor oils, but rather to the wear and destruction of machine parts through the inefficient or incomplete lubricating film provided by poor or unsuitable oils. This wearing of bearings and cylinders increases the friction and likewise the amount of coal necessary to develop the desired amount of power.

There are two ways of handling this problem of lubricating steam cylinders. One method is to take the engine as it stands, with all accessories ready for service, and after considering all of the influencing factors, select the oil which will best meet the existing conditions. Sometimes it is possible to make changes in the installation, favoring the use of an oil that will give better cylinder lubrication than could be secured from another oil selected to meet the existing mechanical conditions.

The other method is to consider the principles of efficient lubrication when the engine and its accessories are designed, built and installed. There is no question but that better lubricating service can be secured at a lower cost for oil and less expense on account of lost power and repairs, if the latter course is adopted. This, of course, requires an expert knowledge of operating conditions and lubricating oils, and entails very close coöperation between the engine builder and the oil manufacturer.

Considering first the design of the engine, the features which influence the method of lubrication and the kind of oil which may be used are the cylinder, the valves, the steam flow and the degree of steam expansion.

Vertical cylinders are comparatively simple to lubricate as the weight of the piston and rings; piston rod, cross head and connecting rod are carried by the

crank pin. The only pressures on the cylinder walls are those due to the tension of the piston rings and possibly to some slight pressure from any side motion which the piston may have. The rings, no matter of what design, should be set out only tightly enough to prevent steam leakage. A film of oil thick enough to prevent excessive friction between these rings and the cylinder walls, and enough oil to maintain this film, are all that is required to provide proper lubrication. The selection of oil is based on the same principles that govern the oil used for horizontal cylinders and the quantity required is very small.

For salt water marine engines where the condensed steam is used for boiler feed, because of the lack of efficient oil separators, the common practice is to run these vertical cylinders without any oil at all and to depend entirely upon the amount of water present in the steam to afford lubrication. The space rings and piston usually have water grooves to hold a small amount of condensed steam which serves to decrease steam leakage, making it possible to use looser fitting rings and consequently decreasing the friction. After a short time, these cylinder walls become highly polished and glazed, so that the actual friction is lessened.

In the horizontal cylinder, except where tail rods are used, the weight of the piston rings and part of the weight of the piston rod must be borne by the lower portion of the cylinder. On account of this weight the piston tends to wear the bottom of the cylinder out of round, and unless sufficient lubrication is provided, the clearance between the piston and the cylinder may become so great as to cause serious leakage of the steam past the piston. This steam increases the pressure to which the oil film is subjected, and may weaken or entirely destroy it. If the rings become worn and sharp on the edges they will scrape the oil film off the surface of the cylinder walls, further increasing friction and wear. Because of these conditions the cylinder oil must have the characteristics which will provide a heavy film of oil and must be used in sufficient quantities to maintain it. Even with the most efficient oil a certain amount of wear will take place and the rings will have to be renewed occasionally.

Engines having heavy pistons and rods are usually provided with tail rod supports which, together with the cross-head, carry the weight of the piston and rods. In such engines the only pressure on the cylinder walls is that carried by the tension of the piston rings, and a thinner film of oil and a lesser quantity of lubricant are required.

The various types of valve gear in common use for controlling the operation of steam engines may be classified as, piston valves, slide valves, Corliss valves and poppet valves. Piston valves or any other form of completely balanced valves are comparatively easy to lubricate as there is no pressure on the valve seat,

except the weight of the valve, and a small amount of oil will afford satisfactory lubrication. Slide valves, unbalanced, or only partially balanced, however, require careful and efficient lubrication, as the sliding action of the valve on its seat, under the pressure of the steam, tends to wipe the oil film off very quickly. Improper lubrication will result in cut or worn valves and seats, and is readily detected by a jerky motion of the valve stem caused by the valve's sticking to the seat momentarily.

Corliss valves are usually the hardest to lubricate because they are held tightly against the seats by the pressure of the steam. The ends of these valves also have to be lubricated and unless they are designed with particular attention to their lubrication, some trouble may be experienced. It is frequently necessary to run a special oil-feed pipe direct to each inlet valve, and sometimes a feed to each end is required. Poppet valves have no moving parts to be lubricated except the valve stems, and this is usually very simple.

Steam engines may also be classed according to the way in which the steam flows through the cylinder. The contra-flow engine is the ordinary type in which steam is admitted and exhausted from the same end of the cylinder. The exhaust steam, being much cooler than the incoming steam, lowers the temperature of the valves and the walls near the end of the cylinder, thus increasing the amount of condensation. This condensation of steam has a great effect on the oil, as will be explained later. The uniflow engine is so designed that the steam flows in one direction only, being admitted at the end and exhausted at the center of the cylinder. These cylinders are very long and on account of low temperatures at the center and the constant washing effect of the wet steam at the exhaust ports, require oil somewhat different from the usual type of engine. The piston is necessarily very long and has a much greater area needing lubrication.

The above statements apply to engines having one or more cylinders, but because of the peculiar operating conditions involved and their effect on the cylinder oil, the compound engine is made the subject of a later paragraph.

The methods of applying the oil to the cylinder and valves may now be given consideration. These methods, it should be realized, are necessarily quite different from those employed in lubricating the internal surfaces of cylinders of internal combustion engines, air compressors, etc. The oil is usually applied in one of two ways. It is either fed directly to the cylinder walls or it is carried in by the steam. The degree of lubrication effected and the economy in the use of the oil depend entirely upon the successful covering of the moving parts with a film of oil.

Oil introduced into the cylinder either runs only a short distance down the side of the cylinder before it is swept toward the end of the cylinder by the piston.

or drops toward the bottom of the cylinder, where it is wiped to the counter-bore at the end of the cylinder without having an opportunity to lubricate anything except a small strip in the bottom. The chances are very great that a falling drop of oil would never strike any part of the cylinder but would be carried out through the exhaust by the steam. This oil, of course, will lubricate the exhaust valves, but where separate inlet valves are used an additional oil-feed must be provided to take care of their lubrication. It should be realized that, while it is entirely possible to lubricate cylinders in this manner—and this method is frequently used—a great deal of oil is necessarily put into the cylinder that has no chance at all of lubricating anything. In fact, when the exhaust steam is used for manufacturing processes and for boiler feed-water, considerable damage may be done by the use of such large quantities of oil unless an extremely efficient oil separator is installed in the exhaust line.

The most efficient way of getting the lubricating oil to all desired points is to make use of the steam itself, which reaches all moving parts inside of the valve chambers and cylinders with the possible exception of parts of certain types of Corliss valves. If the oil is divided into minute globules and intimately mixed with the steam, only a very small quantity is required, and the degree of success in the atomization of the oil will control both the efficiency of lubrication of the parts and the quantity necessary. The more complete the atomization and the more thoroughly saturated all portions of the steam, the better will be the lubrication of all of the cylinder parts, and the more economical will be the consumption of oil.

The degree of atomization of the oil is influenced by the condition of the steam, the point of introduction of the oil, the velocity of the steam, and the character of the oil itself. Other things being equal, a high steam pressure will produce quicker atomization of a given oil than a low steam pressure, due to the high temperature thinning down the oil to a greater extent, so that a comparatively heavy bodied oil may be atomized by a high pressure steam as quickly as a light bodied oil will be atomized by a low pressure steam. Conversely, a low pressure steam requires a light bodied oil in order to secure efficient atomization.

The degree of atomization is also affected by the point of introduction of the oil into the steam, in that the farther the point of introduction is from the cylinder, the greater will be the opportunity for complete atomization. If the oil is introduced directly into the valve chest or just above the throttle, an oil must be used which will break up very quickly. On the other hand, if the point of introduction is from 6 to 8 feet from the cylinder, it is possible to use a slower acting oil if other conditions render it necessary or advisable. Further, if it is found necessary to use a heavy bodied oil to meet the cylinder conditions, better lubrication

may be secured at a more economical cost by placing the introduction of the oil further back from the cylinder. There is a limit, however, to the distance practical, as if the oil is put into the steam too far from the cylinder, too much condensation of oil on the sides of the steam pipe will occur, and result in a greater oil consumption, as the oil will run down into the steam chest without vaporizing.

Cylinder oils have certain inherent characteristics in regard to their ability to atomize which, in general, are as follows: A light bodied oil will atomize more quickly than an unfiltered oil. A cylinder oil compounded with animal oils has a greater tendency to atomize than the same cylinder stock without the compounding.

Atomization of the oil is usually accomplished by introducing it into the steam line through a small pipe, spoon shaped at the open end, extending to about the center of the steam line. Care should be taken to place the introduction pipe so that there are as few bends between it and the cylinder as possible, as the steam striking the pipe at the bend throws out some of the oil onto the pipe where it sticks and runs down the side. If a steam separator is installed the oil should always be fed between the separator and the

engine, otherwise the separator will remove a considerable part of the oil. Better atomization of any oil can be secured by feeding very small drops at frequent intervals than by feeding large drops at long intervals.

Practical experience and many tests have demonstrated the soundness of the atomization theory, and the fact that the most efficient results can be secured in this way. While, of course, a considerable amount of oil which is carried by the steam never comes in contact with the metal surfaces, nevertheless, it has been clearly shown that far less oil is wasted when the oil is completely atomized than when it is introduced directly into the cylinder or valves. The primary consideration is, of course, the efficient lubrication of the cylinders, and the oil should be selected with this in view. Then if the point of introduction is not right to handle the oil selected and if the mechanical conditions will permit, the point of introduction of the oil should be changed to secure proper atomization of the oil. Many times, however, it is not feasible to locate the introduction pipe at the correct point, and it becomes necessary to compromise by changing the character of the oil or by increasing the amount used.

Testing and Inspection of Refractory Brick

Unnecessary Loss of Money, Time and Production Caused by Lack of Proper Testing and Inspection of Refractory Brick Before Being Put Into Service.

By C. E. NESBITT and M. L. BELL.

In nearly all industries, both raw material and finished products are bought and sold on specifications. These specifications vary from the most exacting to those in which nothing of importance is specified. The specifications for refractory bricks unfortunately come in the second class. This condition is very unsatisfactory, and it is felt that the time is rapidly approaching when specifications covering the important industrial qualities desired will have to be written.

A few simple specifications for refractories have been written. Some are in use, but they are of little practical value. Many tests advocated at the present time for refractories are not suited for use in specifications, as they do not show important qualities or are entirely too slow to be commercially applied. A manufacturer or consumer may handle daily from 50,000 to 150,000 bricks. If only one brick in every 1,000 is taken as a representative sample, it means that from 50 to 150 bricks must be sampled, tested and reported upon each day; hence, it is obvious that tests

to be of commercial importance must be rapid, and to be of value must give definite values indicating the fitness or unfitness of the brick for the purpose intended.

The inspection of brick will probably have to proceed along lines similar to that of steel, which has been worked out most carefully and thoroughly. Steel is produced rapidly and in large quantities and is tested by the manufacturer throughout all its primary stages so that he knows the finished product will be of good quality. In like manner the brick manufacturer will have to test the brick during manufacture to insure uniform grinding, molding, drying and burning, resulting in consequent uniformity of product. A great deal of research work will have to be done by the brick manufacturer to determine what methods he should pursue, and like the steel manufacturer, he must know that his finished product will be of good quality.

Different industries require different physical properties in bricks. Specifications for brick should cover only those properties of the brick that are essential for

Paper read before American Society for Testing Materials, Atlantic City, N. J., June 25-28, 1918.

some particular purpose. In testing bricks for the iron and steel industry we feel that the most important qualities can be satisfactorily determined by a few simple tests. In the case of silica brick, which are not ordinarily subjected to the action of slag, a spalling and a hot crushing test are considered suf-

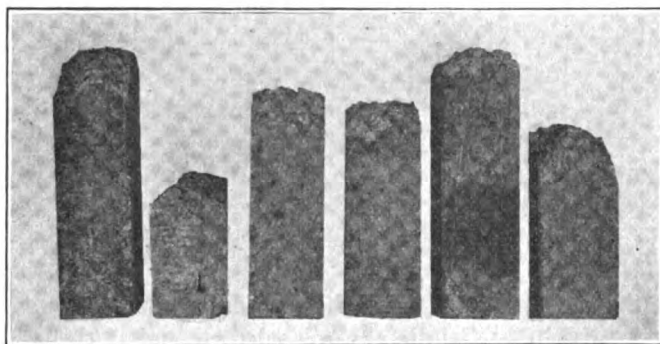


Fig. 1—Illustration of wide variations in spalling of a standard 9-inch silica brick.

ficient; while clay brick should be subjected to load, spalling and slagging tests. These tests cover the particular qualities the brick must possess to give good service.

In addition to such tests it is, of course, very important that the brick shall be subject to a careful visual inspection to guard against the acceptance of cracked or warped brick, poorly molded, off-size, or badly burned brick.

One does not have to go far in the testing of bricks to note the wide variations in the results, which reflect the variation in the bricks themselves. This is

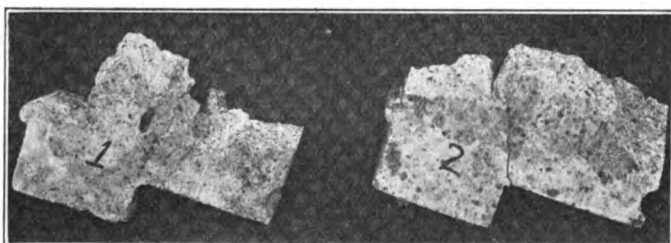


Fig. 2—Showing variation in spalling loss of two 60-pound silica shapes.

- (a) Defective on visual inspection; spalling loss, 46 per cent. (b) Good; spalling loss, 32 per cent.

illustrated by the wide differences in the results of various tests given in the following tables.

Spalling.

Spalling or resistance to sudden thermal change is a most important quality in bricks, especially silica bricks. It is a very common cause of failure. In Table I are shown the results of spalling tests on five

TABLE I.

Loss by Spalling of One Brand of Silica Brick.
All values are expressed as percentage.

Shipment No.				
1	2	3	4	5
11.72	13.39	12.65	11.24	14.96
13.95	15.53	13.44	12.45	21.01
15.08	16.22	17.60	13.94	21.96
19.47	20.38	19.01	19.53	23.93
22.39	21.84	28.29	21.43	28.11
24.12	23.48	23.32	22.51	29.47
25.95	24.31	32.95	22.64	29.76
32.45	24.80	34.03	24.81	30.88
39.84	37.25	35.95	27.39	31.73
40.80	42.27	41.31	30.00	38.34
Average...	24.58	25.86	20.59	27.02

successive shipments of one brand of silica brick. These tests were made in accordance with method given for "Spalling" in the appendix of our paper presented to the society last year, entitled "Suggested Improvements in the Manufacture of Silica Brick."¹

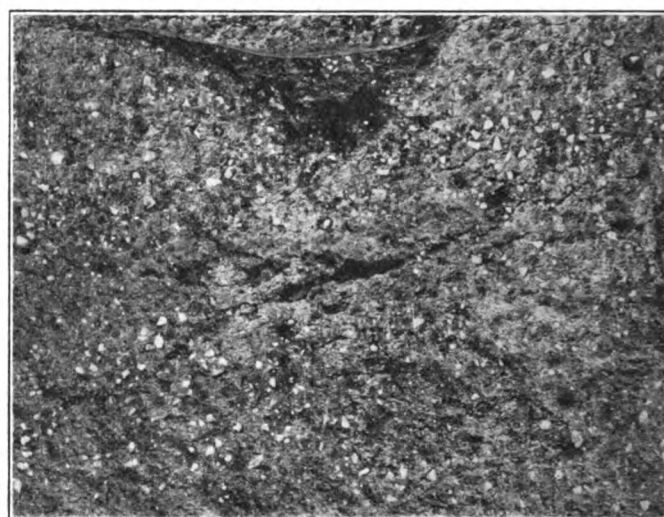


Fig. 3—Example of variation in internal structure of silica shape which by visual inspection would have been considered satisfactory. Note holes and cracks due to improper molding, which would have been detected by a spalling test.

It will be noted that the spalling loss on bricks from the same shipment varied from 11.72 to 40.80 per cent in one case and 13.39 to 42.27 per cent in another shipment, although the average for all the shipments was about 25 per cent. Such variations are due to lack of uniformity in grinding, molding and general workmanship, all of which can be largely eliminated with proper care. Figs. 1 and 2 show typical examples of the variations found in making spalling tests. Figs. 3 and 4 illustrate one cause of failure in spalling tests.

Crushing Tests.

Similar lack of uniformity has likewise been shown by the crushing test. A series of tests were made on a number of commercial bricks, the object being to determine the variation in actual crushing strength of

¹ Proceedings, Am. Soc. Test. Mats., Vol. XVII, Part II, p. 468 (1917).

bricks from the same shipment and the relative crushing strength of different brands of brick when tested at different temperatures.

TABLE II.

Crushing tests on clay and silica bricks.

Brick.	Crushing strength, lb. per sq. in., at			Load, lb. per sq. in., required to cause first deformation at	
	30° C.	1,000° C.	1,350° C.	1,000° C.	1,350° C.
Clay A	850	2055	662		364
	1143	2068	828		513
	1254	2639	1013	806	540
	1292	2913	1112	1111	556
	1351	2981	1307	1120	563
	1567	3086	1343	1458	573
	1812	3132	1581	1671	583
	2091	3135	1657	1711	585
	2469	3182	1683	1835	625
	2853	3735	1708	1956	861
Average....	1668	2892	1289	1458	576
Clay B	1274	3686	757		105
	1341	3698	803		430
	1387	3843	803		649
	1442	4190	814	No deformation before fracture.	649
	1695	4259	928		706
	1698	4376	980		725
	1843	4559	1017		752
	1954	4559	1018		769
	2196	4672	1171		911
	2603	4739	1188		991
Average....	1743	4258	948		669
Silica C	2921	762	820		
	3286	1116	1390		
	3454	1217	1736		
	3657	1775	1743		
	3837	2227	1766	No deformation before fracture.	
	3911	2236	1861		
	4154	2435	1961		
	4164	2720	2221		
Average....	4452	2781	2378		
	5810	4219	2434		
	3965	2148	1831		
	1037	1026	547		
	1320	1051	669		
	1499	1235	702		
	1548	1248	783		
	1701	1308	822	No deformation before fracture.	
Silica D	1738	1614	912		
	1912	1693	938		
	1974	1696	945		
	2057	1723	1060		
	2222	3274	1120		
	1700	1587	850		
	1317	858	465		
	1432	1137	551		
Silica E	2078	1205	597		
	2117	1217	675		
	2530	1285	719	No deformation before fracture.	
	2548	1333	1152		
	2823	1389	1285		
	2967	1498	1289		
	3158	1563	1541		
	3988	1895			
Average....	2496	1338	919		
Silica F	1420	933	275		
	1643	949	283		
	1658	1062	299		
	1760	1151	318		
	1795	1191	427	No deformation before fracture.	
	1911	1237	458		
	1941	1240	470		
	2250	1574	475		
	2479	1596	492		
	2513	1877	808		
Average....	1937	1281	430		

Six different brands were represented, of which two brands were clay bricks and four silica bricks, all of supposedly good quality. In sampling, all bricks

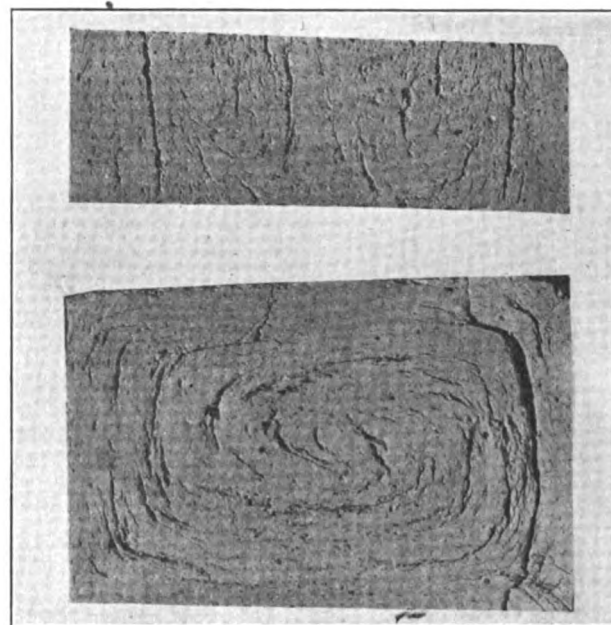
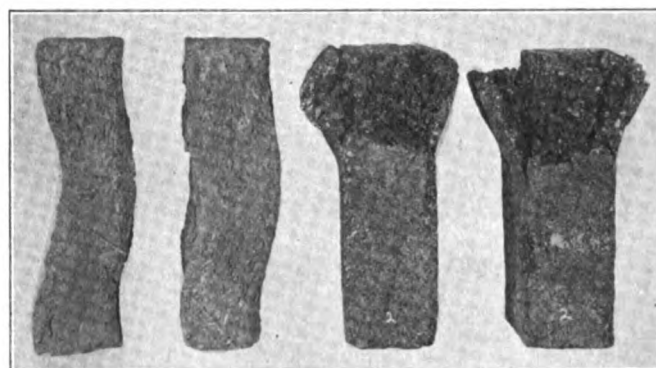


Fig. 4—Two first-grade refractory brick, showing poor texture which often causes premature failure.

of each individual make were chosen from a single order and represent several cars. Only bricks judged to be good by visual inspection were taken for the test. The bricks were prepared and tested as described in the appendix of our paper before the society last year, referred to above.

It will be noted that the total crushing strength of clay brick at 1,000 deg. C. is apparently higher than the strength at 30 deg. C., but this is misleading. At elevated temperatures clay bricks start to splinter off before being completely crushed. The first splintering or deformation is recorded in the right-hand columns



At 1,000 deg. C. At 1,350 deg. C.
Fig. 5—Examples of deformation of clay brick as result of crushing test.

of the table and show that the results obtained at first deformation at 1,000 deg. C. are lower than 30 deg. C., which is in accord with the results obtained

on silica bricks; namely, the higher the temperature, the weaker the brick. (Figs. 5 and 6.)

While both clay and silica bricks are represented in Table II, we do not favor the hot crushing test for

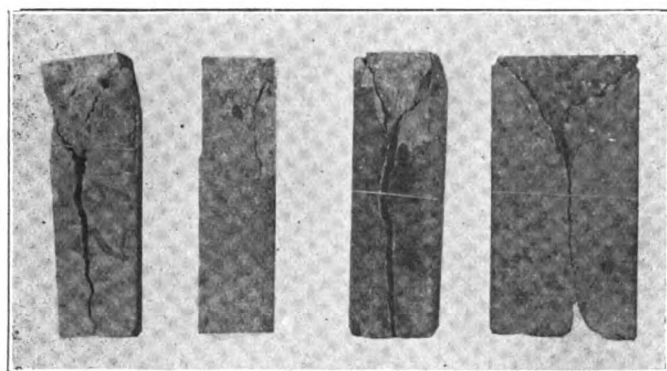


Fig. 6—Typical examples of fractures of silica brick as result of crushing test.

clay brick, the load or ball impression test being more suitable.

Slag Penetration.

Lack of uniformity of product is not shown by the spalling and crushing tests alone, but also by the variations in slag penetration. This is largely governed by lack of uniform structure, due to lack of uniform grinding, molding and burning. This condition is best illustrated by Figs. 7 and 8.

Conclusion.

The results of a few tests such as we have shown here point out the necessity for the inspection of refractory brick. Inspection and testing seem to be the only means of obtaining brick of uniform quality. At present the consumer is forced to accept brick without direct information as to their quality. Many instances can be cited where brick of poor quality have been accepted without knowledge of their inferiority, resulting in the premature failure of the furnace or other structure in which they were used and causing an unnecessary loss of money, time and production.

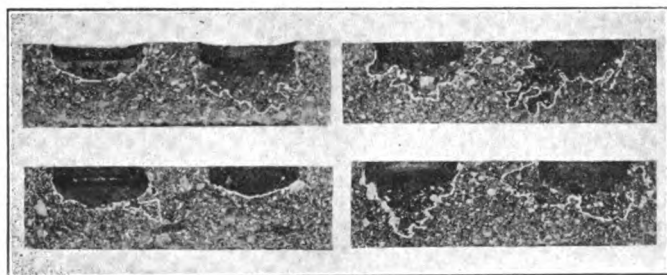


Fig. 7—Typical examples of how slag penetration follows lines of weakness in brick structure.

Much of this loss could have been avoided if the bricks had been tested before being put into service.

Before the bricks are shipped by the manufacturer a great deal can be accomplished by careful visual

inspection, by means of which all bricks irregular in shape, off size, fire cracked, improperly molded, and of poor general appearance would be eliminated. If proper care is taken in the brick plant this rejection need not be a very large percentage of the output. A storage shed should be provided so that bricks may be taken from the kiln and stored for a period of time sufficient for this inspection and the necessary tests. The present methods of making refractory brick do not produce a uniform product. The consumer is powerless to change present methods. To secure greater uniformity, he must adopt specifications for brick with the end in view, not to reject material which is good, but to guard against the acceptance of that which is bad.

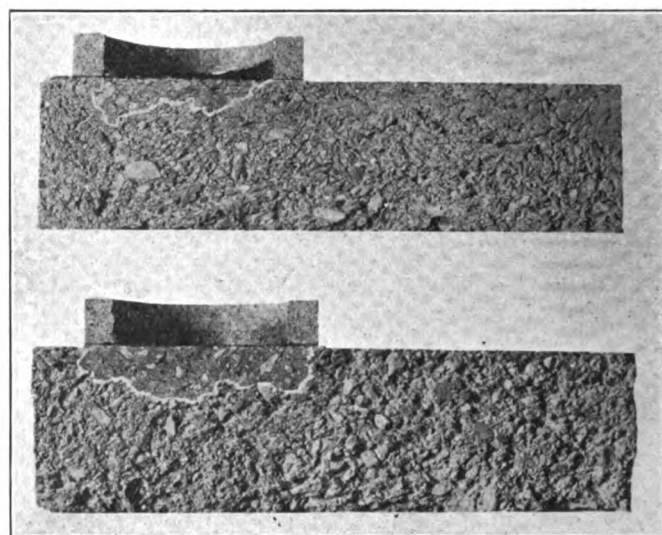


Fig. 8—Two bricks from same shipment—Note difference in texture and resulting variation in slag penetration—Upper brick, 1.13 per cent; lower brick, 2.13 per cent.

DISCUSSION.

By J. S. UNGER.

The authors of this article have touched upon a very important point in brick quality, when they refer to lack of uniformity in commercial bricks. Much could be added to give this greater weight. A few examples will suffice to make this clearer.

I have seen a single high-grade 9-inch firebrick show six times greater loss on abrasion at one end when compared with the other, when tested at 1,350 deg. C.

Single bricks of either fireclay or of silica have shown twice as much slag penetration at points not over 2 inches apart on the same side of the brick and at the same time and conditions of testing. A brick may be cut into halves transversely and opposite faces tested for slag penetration, showing four times as much slag penetration on one face as on the other. Nesbitt and Bell illustrate this point in their Fig. 8.

This same lack of uniformity is shown by spalling, crushing and some other tests, and is not confined to

an occasional brick, but is so prevalent that it can be stated that one brick out of every three is abnormal, the other two do not check one another, nor will any of the bricks show approximate results at both ends.

The authors show great variations in spalling in Table I, and on crushing in Table II, third column of table. These results are startling, but they explain why such poor service is at times obtained from brick, in fact, they make one wonder that brick ever stand up in service.

In a furnace wall where one brick is resting on another, the whole being bound together and not subjected to an excessive load, the lack of uniformity in bricks is not easily detected and may not cause the failure of the structure. If used in a roof or in the arches of flues where each brick acts as a single unit,

the poor or non-uniform brick measures the life of the whole structure.

The trade requires a more uniform brick. There is not a great demand for special refractory bricks made of comparatively rare materials at considerable increased cost, but there is an urgent demand for uniform bricks made of easily available materials.

More uniform quality can be attained by better methods of manufacture. Some brick plants may have to change many of their methods and ideas. It is to be hoped that such changes will be made by the maker without forcing him to make bricks to a specification.

The question may be summed up in this way. The present bricks are not of uniform quality. The customer must have uniformity in quality, to obtain uniformity in service.

Discussion of Article on Powdered Coal

Comparative Tests With Both Powdered Coal and Producer Gas Made on Same Furnaces Under Similar Working Conditions Are Presented.

In the July issue of THE BLAST FURNACE AND STEEL PLANT an article was published under the title, "Substituting Powdered Coal for Other Fuels." In this article exception was taken to the results I had obtained in regard to costs of plants and operation, as shown in the article, "Making Substitutions for Natural Gas," published in the April issue of this magazine.

In order not to go too far into details, the following discussion will be confined mainly to producer gas and powdered coal.

The writer of the above named article states, on page 285, that "the comparisons are not estimated facts, but are based on data secured from the operators themselves in each instance." The article then goes on to say, that to heat one ton of steel it requires

600 pounds of coal in gas producers,
4,000 cubic feet of natural gas,
30 gallons of coal,
600 pounds of coal in hand-fired furnaces, and
300 pounds of powdered coal.

Now the question arises: Have these figures been obtained from tests made on the same furnaces and under the same working conditions? If this is not the case and if the figures have been collected from different sources, they do not prove what they are supposed to prove and are, therefore, without value for the purpose in question. This can easily be seen from the following data.

Tests made at different times on the same heating furnace showed, per ton of steel heated, a consumption of 1,970 cubic feet and 2,500 cubic feet of natural

gas. Another furnace had a gas consumption varying between 2,000 and 4,000 cubic feet. In both cases the high figures were due either to incomplete combustion or to some other bad condition of the furnaces, i. e., to uneconomical working conditions. Economical working conditions are shown in the next figures. Four tests made on another type of a heating furnace gave an average of 1,327 cubic feet of natural gas per ton, while on a fourth furnace an average of 1,071 cubic feet (from five tests) was consumed.

The same holds good for coal-fired furnaces; variations between 200 and 400 pounds of coal, even as high as 500 pounds have been encountered, but the high figures could always be traced back to uneconomical working conditions. It is, for this reason, not correct to compare figures obtained from different furnaces without stating the conditions under which they were taken, and it is still less correct to use such figures for comparing the value of different kinds of fuel.

That the differences between different fuels are not as large as shown in the article cited, may be seen from tests made on the same type of a furnace under the same working conditions with powdered coal, oil and producer gas. The furnace consumed, per ton of material produced:

525 to 775 pounds of powdered coal,
58 gallons of oil,
675 pounds of coal for producer gas, when running uneconomically,
525 to 580 pounds of coal for producer gas, when running economically.

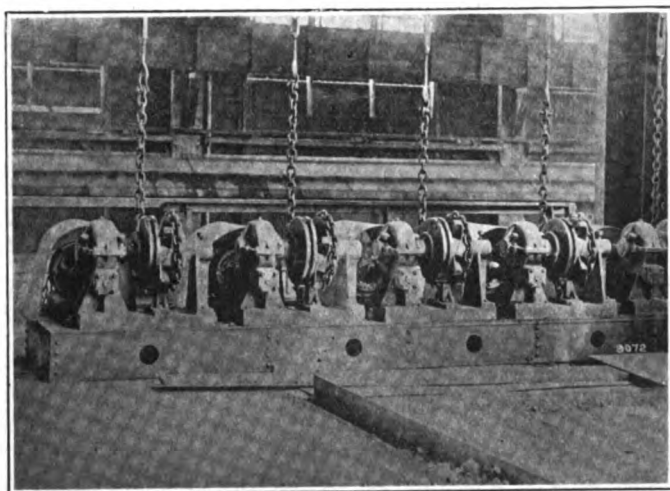
This shows that the coal consumption for powdered
(Continued on page 347)

PRODUCTION TOPICS

THE LEWIS HOIST.

The operation of heavy doors, such as are used on open hearth and heating furnace work, is usually accomplished by the use of hydraulic systems, consisting of pumps, pressure tanks, high pressure pipes, three-way valves, etc. On account of the fact that doors must go up when wanted to go, and vice versa, and due also to the fact that water under pressure has been reliable in the past, the hydraulic system has almost universally been adopted. This is also proof of the fact that no foolproof, absolutely dependable electric control has ever been worked out before for open hearth work. A few electric attachments have been made, but they resulted in failure.

The Alan Wood Iron & Steel Company, Conshohocken, Pa., have had in use for 13 or 14 months, five hoists with an



automatic release, invented by one of their men and manufactured by the Link-Belt Company. These hoists have been in continuous and regular operation without any repairs, attention or maintenance expense whatever. The illustration shows each hoist provided with a pair of chain sheaves, mounted loose on a worm wheel shaft, between two flanges which are pinned to the shaft and supplied with fiber friction surfaces on the sides toward the sheaves. The worm wheel is driven by a worm mounted on the shaft of a reversible motor, the worm and wheel being enclosed in suitable housing.

To the left-hand sheave is attached a chain which leads up to the tackle for raising the furnace door, and to the right-hand sheave is fastened a chain from which is suspended a heavy counterweight (down behind the mechanism shown). The wrap of the chains around the sheaves is in opposite directions. The contact surfaces between the sheaves have a beveled, or spiral shape, with the result that when both chains are under tension, the sheaves are squeezed tightly against the friction flanges at the sides, and thus compelled to rotate in the direction of motion of the worm wheel shaft.

To raise the furnace door, the motor is started in the direction which will pull down on the left-hand chain. As long as the counterweight continues its pull, the sheaves squeeze out against the flanges, and are thereby driven in the direction which will wind up the left-hand chain, and thus lift the

door. The right-hand sheave has a fixed stop on its periphery, so located that it will come in contact with a stop on the bottom casting when the furnace door has reached its proper height. With the motion of the right-hand sheave arrested by this stop, the shaft cannot rotate the left-hand sheave further, because the squeeze between the sheaves and friction flanges is relieved. There is no opportunity, therefore, for over-winding, and if through carelessness the current is not shut off promptly, the shaft with its flanges will simply continue to revolve in sliding frictional contact with the sheaves, but without power to grip and rotate them further.

For lowering the doors, the direction of the motor is reversed, and practically the same process repeated, except that in this case the power of the motor is used to lift the counterweight, while the pull from the weight of the door serves to keep the sheaves squeezed apart against the friction flanges, until a stop on the left-hand sheave engages with a stop on the bottom casting, and prevents over-winding of the counterweight chain in the same manner as described for the other sheave. In other words, the door always goes up to the proper position, and always comes down to the proper position, no matter what its weight may be. Even if the door were considerably heavier than the counterweight, there would be no danger of its descending and pulling the counterweight up when the motor is stopped, for the instant the counterweight sheave is started toward reversal, the pull of its chain would squeeze the sheaves apart against the friction flanges, and the two sheaves would thus be put completely under control of the worm wheel shaft again, and the worm wheel is, of course, locked in position by the worm.

The stop feature does away with the automatic electric switch devices which have proved so troublesome for this type of hoist, as well as for skip hoists; and it secures an exact stop for all such hoists, without involving failure from human carelessness or complicated electrical equipment. The motor is started, stopped or reversed by simple push-button mechanism.

In the case of skip hoists, the sheaves, of course, would be replaced by drums. Doubtless various other applications of the device will suggest themselves; and the fact that it is entirely foolproof will be appreciated as a great advantage.

SAVES MONEY BY ARC-WELDING.

Arc-welding has been brought prominently before the public through the fact that it was used to restore the broken engine castings of the interned German ships. When breaking these castings the Germans thought they could not be repaired, and that it would require a year or more to replace them. However, even before the ships could be otherwise overhauled and made ready for transport service the broken castings had all been repaired and were good as new. This achievement has impressed the value of arc-welding upon the minds of many shop managers, and in many plants castings and other parts of apparatus which in the past would have been scrapped as hopelessly damaged, are now perfectly restored by the arc-welding process at small cost and great saving of time.

One large manufacturer, working on munitions, has installed a Westinghouse arc-welding equipment for the sole purpose of making tools for turning shells.

NEWS OF THE PLANTS

IRON AND STEEL PLANTS.

The Phillips Sheet & Tin Plate Company, Weirton, W. Va., is having plans prepared by Freyn, Brassert & Co., engineers and contractors, People's Gas Building, Chicago, Ill., for the construction of a new blast furnace with daily capacity of about 600 tons. In connection with the furnace a battery of 47 by-product coke ovens will be erected for the production of coke for operation, and for gas supply to the present tin mills. A plant for the production of benzol will also be constructed, to be used for government service. It is expected to have the new plant completed and ready for operation in about eleven months. D. M. Weir is vice president of the company.

The International Steel Tube & Rolling Mills, Inc., Guardian Building, Cleveland, O., is having plans prepared for the construction of six new rolling mills and steel tube works at Warren, O., to cost about \$500,000. The structures will be one-story, averaging from 300 by 500 feet to 80 by 100 feet. O. R. Gimmesey is president.

Henry L. Brittain, president of the Mobile Shipbuilding Company, Mobile, Ala., and vice president of the Terry Shipbuilding Company, Port Wentworth, Ga., is organizing a new company to build a plant near Birmingham, Ala., for the manufacture of steel plates and structural shapes for shipbuilding work. A site has been secured for the proposed plant, consisting of about fifty acres and preliminary plans are under way for the mills. It is said that the initial cost of the works is estimated at \$1,000,000 and that the first unit is expected to be ready for service in from four to six months. The Emergency Fleet Corporation, Washington, D. C., is interested in the project.

The Texas Steel Company has completed the remodeling of the iron furnace and auxiliary structures at Rusk, Tex., recently acquired from the state, and is planning for the early operation of the plant. Plans are under way for the construction of a new iron and steel works at Beaumont, which will be used in conjunction with the Rusk plant. Col. L. P. Featherstone is president.

The Anaconda Copper Mining Company, 42 Broadway, New York, is making rapid progress in the construction of a new plant at Anaconda, Mont., for the production of ferromanganese. The company expects to place the first unit of its proposed five-unit plant in operation during August, closely following with the other sections. The annual production at the new works is estimated at 30,000 to 40,000 tons, and figuring production costs and market prices the profit will average close to \$25 per ton.

The Sheffield Iron Corporation, Sheffield, Ala., has completed the remodeling of three blast furnaces at its plant, and is planning to blow in the different units at an early date. Furnace No. 1, the first to be placed in blast, will have a daily capacity of about 250 tons of iron. The new installation includes furnace stoves, boilers, engines, pumping machinery, locomotive cranes and other equipment. Warren L. Kluttz is general manager.

Preliminary plans have been prepared by the Tri-City Steel Company, Railroad Exchange Building, St. Louis, Mo., for the construction of a new one-story steel rolling mill, about 100 by 320 feet, to cost about \$75,000. S. E. Camp is president.

BOILER WORKS FOR GOVERNMENT TO COST \$4,000,000.

The Emergency Fleet Corporation has completed negotiations with the Newport News Shipbuilding & Drydock Company, Newport News, Va., for the construction of a new plant for the production of boilers for marine service, to cost about \$4,000,000. A site for the works has been secured on the James River, near Richmond, Va., and plans are under way for the different mills and shops to compose the plant. It is stated that the plant will be the largest boiler works in the country and will give employment to about 2,000 men. It is expected to have the plant ready for operation by the close of the year.

NEW COKE PLANTS.

A battery of 80 coke ovens has been completed at the Steelton, Pa., works of the Bethlehem Steel Corporation, following construction for the past 18 months. The new ovens, now in operation, were erected by the H. Koppers Company and have a daily output of about 18 cars. The normal production heretofore from a battery of 120 ovens has been about 25 cars, making a total output of about 43 cars with 200 ovens in operation. The average consumption of fuel at the furnaces of the company approximate 65 cars daily, so that the total production from all ovens is not sufficient to provide for local requirements. The company is planning to place its new blast furnace A in operation in August; this furnace is nearing completion after many months of construction and after being blown in will replace No. 1 furnace, which will be shut down for repairs. Six furnaces are now in blast at the local works.

DISCUSSION OF ARTICLE ON POWDERED COAL.

(Continued from page 345)

coal and for producer gas is at least the same, if not in favor of the latter kind of fuel, and not by any means twice as high for producer gas than for powdered coal as was stated in the article.

Keeping this in mind and considering furthermore that one man can easily take care of two producers instead of one only, and that the steam consumption for good running practice is about .3 pounds per pound of coal gasified (in place of 1 pound/1 pound), the figures given for the total cost per day for producer gas \$536.20, (p. 286) can be materially reduced and will show no marked difference from the cost for powdered coal. Thus, practically, the same result will be obtained as was given in my article in the April issue of THE BLAST FURNACE AND STEEL PLANT.

ELECTRIC FURNACE MANUFACTURERS MEET.

A recent meeting held at the Yale Club, New York City, of certain electric furnace manufacturers of the United States was at the request of the General War Service Committee of the electrical manufacturing industry. At this meeting C. L. Collins, representing the General War Service Committee, presided, and stated that in his opinion the electric furnace manufacturers should consolidate in the form of a unified organization to act under the General War Service Committee in preparing and guaranteeing information in connection with the electric furnace industry to assist the government in its war preparations.

Some Pointers on By-Product Coke Oven Operations

THE BY-PRODUCT COKE OVEN; ITS PRODUCTS.

By WILLIAM HUTTON BLAUVELT.*

Attempts have been made to obtain higher yields of ammonia by blowing steam into the coke, somewhat after the manner followed with the Mond producer, which recovers from three to four times as much ammonia, but none of these processes have been developed commercially. Higher coking heats tend to break down the combinations to their ultimate elements.

For example, the gas produced from high-temperature coking will contain more hydrogen and less marsh gas, and a larger volume will be produced of lower calorific value. When coking at very low temperatures, as in the production of "Coalite," practically no benzols are produced and the hydro-carbons recovered are of the aliphatic series. At high coking temperatures the tendency is for the toluol, the more complex hydro-carbon, to break down into benzol, and at very high temperatures the yields of both are reduced. The temperature conditions to which any particular particle of hydro-carbon is submitted in its travel from the original piece of coal up to the hydraulic main are so complicated and so varied that a theoretical discussion of these reactions is of little value.

Cooling the Gas.

The gases passing off from the oven are heavily laden with various hydro-carbon vapors and with water vapor and consequently carry a large amount of latent heat. So the cooling of the gas and the condensation of the vapors require efficient condensing apparatus and large amounts of water. The gas works manager of early days used to deal gently with his gases in removing the tarry vapors and cooled them very slowly in order to prevent their taking up the benzols from the gas, with injury to its illuminating power, but in the coke oven practice this precaution is not considered necessary.

Much improvement has been effected in the efficiency of the condensing apparatus since the early days of the tubular cooler, in which the gas circulated around the tubes of an apparatus similar to a vertical boiler, while the cooling water flowed through the tubes on the counter-current principle. I have in mind one single-stage condensing apparatus 10 feet (3 m) in diameter and 45 feet (13.7 m) in height of effective cooling surface in which 12,000,000 cubic feet (340,000 cubic m) of gas per day is cooled on the average from 80 to 20 deg. C., in which the cooling liquor enters the apparatus at a temperature 5 deg. below the exit temperature of the gas, and leaves it at not more than 10 deg. below the entering gas temperature. In such an apparatus very little condensate separates from the gas at a low temperature, and as a result the benzols remain in the gas and the separation of tarry matter from the ammonia liquor is sharp and easily effected.

Removal of Tar.

A small quantity of the lightest tar vapors remain in the gas with the benzols. These may be removed by some efficient form of the old Pelouse and Anzin tar extractor, or where the gas is washed with water to remove the ammonia in the indirect process of ammonia recovery, these light tars are efficiently washed out. An efficient system of removing these light tars in a high-tension electric field has been de-

veloped by F. W. Steere, the plan adopted being similar to that used in the well-known Cottrell system, except that the special conditions permit the use of an alternating current of the necessary high voltage, since the problem is merely the agglomeration of the minute globules of tar to permit their effective removal by tar extractors of the usual type. This process has been worked out commercially and is simple and effective.

Tar as Fuel.

One of the interesting developments in the operation of by-product ovens in connection with steel plants is the growing use of tar as a fuel for metallurgical furnaces. I have in mind one plant producing over 20,000,000 gallons of tar per year, in which the entire amount has for years been utilized as fuel in open hearth and heating furnaces, where its value as fuel is much higher than its value in the ordinary tar market. Generally speaking, the tar used in steel furnaces is handled in the same manner as ordinary petroleum fuel oil, having about the same viscosity, and its use presents no difficulties after the details of its application have been worked out. It has a higher fuel value per gallon than ordinary fuel oil.

Recovery of Ammonia.

It was formerly the universal practice to extract the ammonia from coke oven gas by scrubbing with water, which has a large capacity for absorbing ammonia at moderate temperatures. This was the old gas works method, and the processes as used in oven plants are the same except as modified to meet the conditions of large volumes and efficient recovery. The ammonia is recovered by these absorbing processes in the form of a crude liquor, usually containing from 0.5 to 1 per cent of ammonia.

This liquor usually contains practically all of its ammonia in the free state, whereas the condensate from the coolers carries considerable amounts of fixed ammonia, sulphate, carbonate, chloride and sulphide. After removal of the tar by decantation the combined liquors are distilled with steam, after setting free the fixed ammonia by means of lime, the product being the crude ammonia liquor of commerce. In other plants the vapors from the still are passed through a sulphuric acid bath and sulphate of ammonia is formed.

The so-called direct and semi-direct processes for the manufacture of ammonium sulphate have been very generally applied to oven plants in recent years. The direct process requires only the removal of the tar from the gas without any more cooling than is necessary for this purpose, after which the gas is passed through a bath of sulphuric acid and the sulphate recovered. The direct process has been applied to a considerable extent in Europe, where the percentage of chlorides in the coal is quite small, but where the amount of chlorides is relatively large it is necessary to remove them before the acid bath is reached.

This introduces the "semi-direct" process, in which the gas is cooled to remove the chlorides and then reheated and passed into the acid. The fixed ammonia condensed out in the cooling process is distilled and generally the ammonia from the stills is returned to the gas before it reaches the acid bath. The percentage of ammonia that has to be distilled in the semi-direct process depends upon the amount of fixed ammonia in the gas and varies from 15 to 40 per cent of the total ammonia.

* Fifth installment of paper read before A. I. M. E. meeting, New York, February, 1918.

INDUSTRIAL SAFETY

LAUNCHING A SAFETY CAMPAIGN.

The following is a record of the personal experiences of a safety engineer who secured increased efficiency, reduced cost of production and reduced labor turnover 50 per cent. It is written in the form of a letter, replying to a request for aid in launching a safety campaign. The author of the letter is W. R. Rasmussen, secretary of the Western Pennsylvania Division, National Safety Council, Pittsburgh, Pa.

Pittsburgh, Pa., April 22, 1918.

My dear Brown:

I am pleased to hear that you have been assigned to the position of safety director of the A. B. C. plant and heartily congratulate you on your promotion. Your request for a few fundamental rules to govern your activities in starting the work is rather difficult to answer in concrete form, because, as you know, a safety man has little time to spend at a desk formulating rules—he must be on the job all the time if he is to make a record. The best I can do is to give you a sketch of my own difficulties and the means I took to overcome them. I hope they will be of service to you.

When I started my work in the X. Y. Z. plant every operating official was prejudiced against the movement—thought it would interfere with production. The only reason I was tolerated at all was because the executive officers of the company demanded that a man be placed in charge of safety work—incidentally, it may be said, the plant carried its own liability insurance.

During the first three months my work was regarded as a joke, not only by the men but by the foremen and sub-foremen. Every noon I visited the lunch rooms and talked to the men and tried to impress upon them the importance of the work, but with little success. A few simple safeguards were installed, but I believe they were made and placed more to pacify me than because the foreman in charge believed in their utility—and these were only installed in the most dangerous parts of the plant. I would have been completely discouraged if I had not felt—no, I knew—that I was right and that all the fun that was poked at me was just plain ignorance of what the safety movement really meant to the very men who were making a laughing stock of it. In looking back over this period of my work I am convinced that most, if not all, of my trouble was caused by lack of diplomacy on my part. I sensed something of the kind even then and one day I determined to drop general work for a time and concentrate all my energies on one specific line. So I did the obvious thing, picked out the most hazardous department in the plant—the one having the most accidents, and set to work to make a detailed study of its hazards and the possibility of remedying them.

Luckily the superintendent in charge was a young fellow, ambitious and progressive, and willing to try out the new proposition.

He had 300 men in his charge and most of them were foreigners—Greeks, Italians, Austrians, Bohemians, etc.—and when I argued that we could go through a month without an accident he thought I was “kidding” him. We got together finally, however; I agreed to spend all my time in his department if he would promise to give me his assistance in working out the new system. I had to promise him that I would not mention the matter to anyone outside his department, because, he argued, if we were unable to make good,

he would be criticised for entering such a foolish undertaking. I promised him all the credit if we succeeded and that finally won him over. Then we got to work.

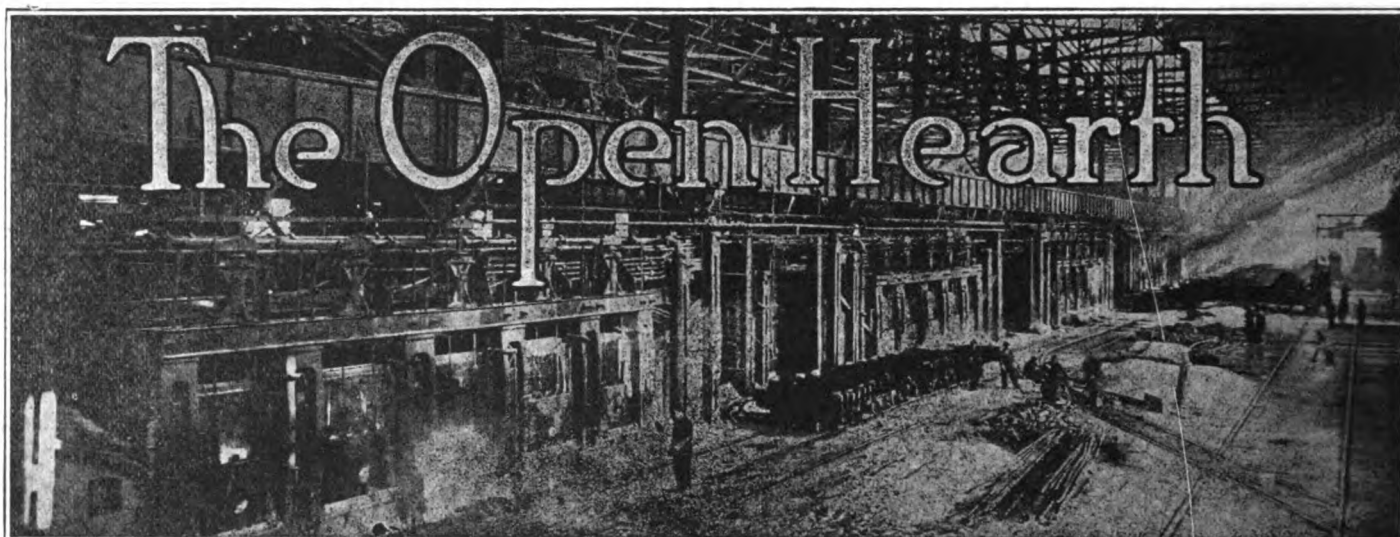
First, we got all the departmental foremen together in his office and explained to them in detail just what we were going to do. We told them that we wanted their cooperation and that they must clean up the department—start “housecleaning.” That was the beginning—clearing aisles and passageways, stacking material in a safe manner and putting tools in their proper places.

In a day or so the department was a different looking place; the men were taking an interest and wondering what was coming next. Well, we showed them. As soon as we got the tools in their proper racks we inspected them and culled out all the imperfect ones and had them redressed; of course, we condemned the ones that were too far gone to repair. Object lesson No. 2 for our men. Then we looked up the toilet rooms and had them cleaned and fumigated and repaired and painted. We improved the lighting conditions in the shop and fixed the floors and work benches, overhauled chains and slings and ropes; repaired wheelbarrows and trucks and put things in shape generally. Of course, this took quite a little time—but every day the men took a firmer hold on the new condition and began to offer suggestions and to do their work in a safer manner.

Then we had another meeting of the foremen and began to plan guards for our machines. You see, we had to prove to the men that we were in earnest and the foremen were the hardest men to convince, but as soon as they found that they were getting a larger product with less effort, they became the strongest advocates of the new order. Sometimes the superintendent and I were on the job 36 hours at a stretch, working with the day force, then with the night gang, and back again with the first crew, but every day the work became easier. By this time the sub-foremen were working every minute and everywhere we went we could hear them cautioning men to be careful and talking safety all the time. We went through the month without an accident.

With this record carefully worked out I visited every other superintendent in the plant, arguing that if the most hazardous department in the shop, where more accidents had occurred than in all the other departments combined, could go 30 days without an accident and with an improved production record, there was no reason why accidents should occur to the men in their charge. Most of them saw the point and safety meetings were held all through the plant, first in the departments and then general meetings were called. We continued our original plan, first getting the foremen together, then the sub-foremen, and finally all the men were called together, using interpreters to drive the lesson home to the last man. Up to the time I refer to the best record for a long time had been 21 time-losing accidents in any one month; since inaugurating the safety campaign our worst record was five—many months we had none. I might add that after the first month or so the general manager became a convert and became one of the best safety boosters I have ever known. He always cooperated in everything we attempted and did not hesitate to devote a large part of his time to the work. He helped put safety on the map and to keep it there—it was a pleasure to work with him.

(To be continued)



JAMES H. HUGHES.
Company began July 1.

James H. Hughes has been appointed manager of the steel and tube department of the Timken Roller Bearing Company, at Canton, O. Mr. Hughes comes to the Timken company as a steel man of parts. He served his apprenticeship with the Carnegie Steel Company, having spent 14 years in that organization. January 1, 1913, he came to Canton as resident representative of the Carnegie Steel Company, the Illinois Steel Company and the Tennessee Coal, Iron & Railroad Company. His official connection with the Timken

H. W. Craig has been appointed manager of sales of the Republic Iron & Steel Company, Chicago district.

Capt. William J. Richards, during the last 18 years general superintendent of the iron ore mines of the McKinney Steel Company, on the Menominee and Gogebic ranges, has retired from active service. He will, however, be connected with the McKinney Steel Company in an advisory capacity.

J. H. Edmunds is now assistant to the general manager of the Lebanon Pa., plants of the Bethlehem Steel Corporation. Mr. Edmunds was in the employ of the American Iron & Steel Manufacturing Company for several years.

George A. Armes, formerly chief engineer for the Union Iron Works Company, San Francisco, is now associated with the Moore Shipbuilding Company, Oakland, Cal.

Harry V. Hunt, formerly general superintendent of the Consolidated Press Company, Hastings, Mich., is now general manager of the O'Neil Iron Works, Buffalo, N. Y.

C. B. Cushwa, general superintendent of the Haselton and Lowellville, O., plants of the Sharon Steel Hoop Company, Sharon, Pa., has resigned, effective September 1. Mr. Cushwa is a director of the Sharon Steel Hoop Company.

Andrew Wheeler, of Morris Wheeler & Co., has gone to Washington to take care of warehouse steel distribution under regulations that have been established by the War Industries Board. Mr. Wheeler received this appointment through invitation by the War Industries Board.

Carl H. Snyder is now with the Buffalo Bolt Company as assistant superintendent of its plant at North Tonawanda, N. Y. Mr. Snyder was formerly with the Steel Company of Canada, Ltd., Hamilton, Ont.

Classification committees have been appointed by the Pittsburgh Region War Resources Committee. The members of the committee on iron and steel products are as follows:

A. M. Harper, Carnegie Steel Company, chairman; H. S. Bickle, Fort Pitt Bridge & Iron Works, representing structural work; I. F. Lehman, Blaw-Knox Company, plate work; J. G. Deericks, Pittsburgh Steel Company, wire nails and wire mills products; Henry Oliver, Oliver Iron & Steel Company, bolts, nuts and rivets; Joseph V. Smith, Hubbard & Co., shovels and spades; H. S. Spangler, McKinney Manufacturing Company, general hardware; E. L. Parker, Columbia Steel & Shafting Company, shafting; James E. Hammond, Superior Steel Corporation, cold rolled strip steel and similar products. The machine shop works committee consists of Charles J. Mesta, Mesta Machine Company; H. D. Wilson, Wilson-Snyder Manufacturing Company.

Henry J. Schlesinger, vice president and treasurer of the Milwaukee Solvay Coke Company, has accepted a commission as captain in the Ordnance Corps, United States Army. He will commence his new activities immediately.

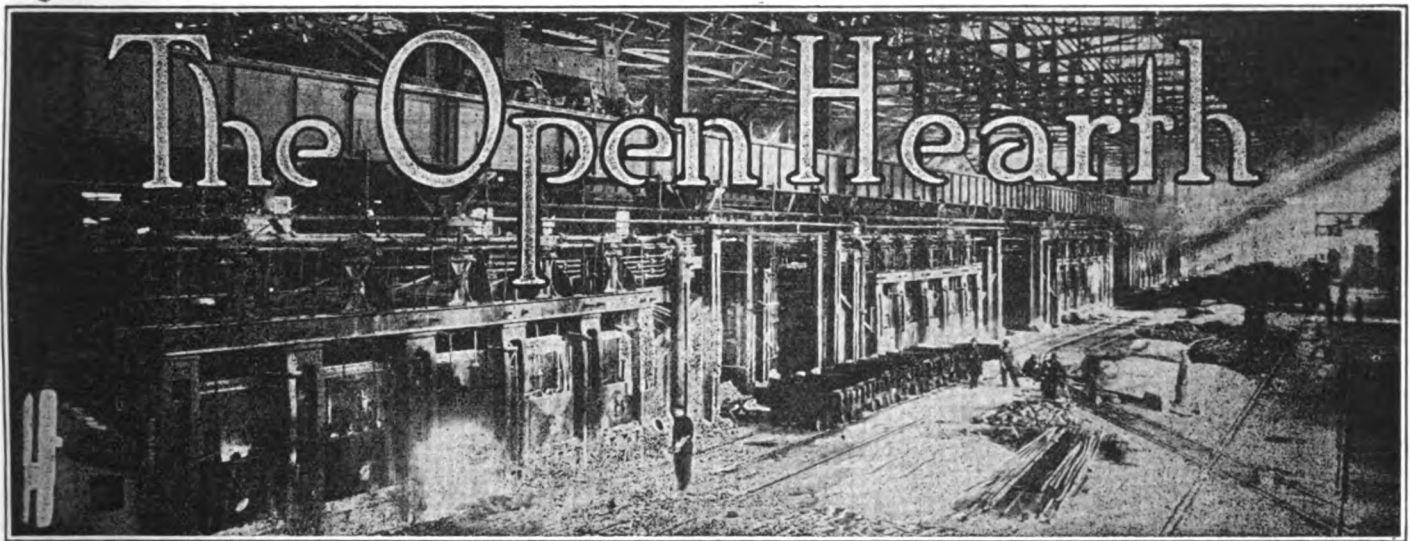
Joseph H. Frantz, vice president and general manager of the Columbus Iron & Steel Company, Columbus, O., has been appointed fuel administrator for Ohio.

Hugh M. Condie is now commercial office manager of the Swedish Iron & Steel Corporation, of New York. He was formerly traffic manager of Warren Webster & Co., Camden, N. J.

Henry F. Jordon has been made general sales manager of the Braeburn Steel Corporation. He was formerly with the Colonial Steel Company and later, for six years, Pittsburgh sales manager of the Braeburn Steel Company.

Howard K. Moore, office manager of Whitaker-Glessner Company, Portsmouth, O., has been appointed assistant to President Andrew Glass.

W. J. Brown, 111 Broadway, N. Y., has been appointed local representative of the Bethlehem Steel Bridge Company and of the Bethlehem Shipbuilding Corporation.



William E. Baer has been appointed auditor for the government in connection with the Neville Island plant, to be built by the United States Steel Corporation.

V V

Charles R. Hook has been appointed a director of the American Rolling Mill Company, to succeed the late James G. Battelle, formerly president of the Columbus Iron & Steel Company, which was absorbed last year by the American Rolling Mill Company. Mr. Hook was for some time night superintendent of the Central works and from there on he was promoted through the offices of the assistant general superintendent, general superintendent, and vice president in charge of the operating division.

V V

Frank H. Crokard, for some time vice president and general manager of the Tennessee Coal, Iron & Railroad Company, and later president of the Nova Scotia Steel & Coal Company, New Glasgow, N. S., has resigned the latter position. He will be succeeded by Donald H. McDougall. Mr. McDougall was appointed assistant general manager of the Dominion Coal Company in 1909. Since 1916 he has been general manager of the Dominion Iron & Steel Company.

V V

George W. Moore has been appointed assistant general superintendent of the Whitaker-Glessner Company, Portsmouth, O. Mr. Moore succeeds J. M. Smith, resigned.

V V

E. F. Flad, formerly in charge of the Youngstown, O., slag crushing plant of the Carnegie Steel Company, has been made chief construction engineer and efficiency expert. He succeeds Fred Hubbard, who is now employed at the Neville Island ordnance plant.

V V

William H. Schuchardt, vice president of the Pelton Steel Company, Milwaukee, Wis., has succeeded H. Harvey, resigned as general manager.

V V

Wesley Martin has resigned as assistant superintendent of the two ammunition shops at Bethlehem, Pa., of the Bethlehem Steel Corporation, to become general superintendent of the Symington-Anderson plant at Chicago.

V V

Charles B. Seem, formerly with Perin & Marshall, consulting engineers, New York, is now connected with the Electric Furnace Company, Alliance, O., in the capacity of sales engineer.

Graham Macfarlane, Jr., is now commissioned lieutenant of engineers at Camp Lee, Petersburg, Va. He was formerly secretary and treasurer of the Red River Iron Works, Clarks-ville, Tenn.

V V

Theodore H. Harvey, general manager and assistant secretary of the Pelton Steel Company, Milwaukee, Wis., has resigned to accept the position of general manager of the Ohio Steel Foundry Company, Springfield, O.

V V

P. B. Findley, technical editor in the department of publicity, Westinghouse Electric & Manufacturing Company, has resigned that position to enter the training school at the University of Pittsburgh, where he will take a special course in radio work with the Signal Corps. Before going to the Westinghouse company he was editor of the "Electrical Age."

V V

Ralph O. Pinkerton, formerly with the Jones & Laughlin Steel Company, has been made assistant paymaster of the Neville Island plant of the ordnance department, United States Steel Corporation.

V V

T. O. Yost, former roller at the Berger works of the Stark Rolling Mill Company, Canton, O., has been appointed assistant superintendent of the Inland Steel Company's sheet mills at Indiana Harbor, Ind.

V V

Howard M. Hanna, Jr., will act as president for the next year of the Detroit Iron & Steel Company, Detroit, Mich. Other officers elected are as follows: Frank Richards, Cleveland, O.; vice president, R. S. Grant, Cleveland, O.; W. S. Whitcomb, Detroit, Mich.; assistant secretary and treasurer; Patrick J. Moran, plant manager.

V V

George Hutchinson has been appointed superintendent of the Chickasaw Shipbuilding Company, Mobile, Ala. Mr. Hutchinson has been yard superintendent of the steel works of the Tennessee Coal, Iron & Railroad Company for the past 12 years. C. E. Farnum succeeds Mr. Hutchinson at Birmingham.

V V

A. M. Minnick, who for two years has been sales manager of the electric furnace department of the Gronwall-Dixon electric melting and refining furnace, has received a first lieutenant's commission in the Ordnance Department. Mr. Minnick was formerly also with the Snyder Electric Furnace Company, Chicago, Ill.

WITH THE EQUIPMENT MANUFACTURERS

POWER-OPERATED ELECTRICAL INSTRUMENTS FOR MEASURING AND CONTROLLING TEMPERATURES.

The most precise electrical measurements are those made by a zero or balance method, such as the Wheatstone bridge and the potentiometer. In both no current flows through the galvanometer at the moment when the measurement is made, and hence galvanometer errors are excluded. In the potentiometer, variations in the resistance of lead wires and of the source of electromotive force, such as a thermocouple, are also eliminated, the lead wires and thermocouple being in the same circuit with the galvanometer.

Zero methods, however, require external power for the balancing of the circuit. For single measurements this power is ordinarily supplied by the hand; a contact is moved along a slide wire or resistances are plugged in or out until the galvanometer comes to the zero position, when the quantity to be measured is at once known from the amount of resistance that has been used. The Leeds & Northrup Company, of Philadelphia, Pa., has developed a line of power-driven recorders, however, in which the adjustments are made automatically, the galvanometer merely determining in which direction the adjustment is to be made.

Early attempts to use a galvanometer for this purpose were along the line of having the boom or pointer of the galvanometer close an electrical circuit. This, however, proved unsatisfactory, as with low voltages on the boom, contact would not be made through particles of dust, while with a higher voltage the boom would "freeze" or fuse to the contactor. In the Leeds & Northrup apparatus the boom serves merely as a mechanical trigger. A reciprocating part, kept in constant motion by a motor, is arranged not to strike the boom when the latter stands in the no-current position, but when the boom moves out of this position in either direction, the reciprocating part pushes it against another part which adjusts the bridge or potentiometer circuit, the amount of the adjustment being regulated according to the distance which the boom has swung, that is, to the unbalancing current through the galvanometer.

The power of the motor is sufficient, not only for making the adjustments, but also for the operation of the chart drum or roll. For this purpose, however, the motor must run at a constant speed, that is, sufficiently constant to give good time-keeping qualities, since the abscissae of the chart are laid off in hours and minutes. This has been found to necessitate

the use of a special governor, and much time and research have been devoted to this problem. The governor finally adopted is of the centrifugal type and operates by opening and closing a shunt in the field circuit. When the motor is in operation this contact is continually on the make and break, as may be easily detected by listening to a telephone receiver connected in the circuit.

The motor not only adjusts the movable contact of the bridge or potentiometer, but also supplies power to move the recording pen. Multiple recording instruments which will record for a number of different thermocouples or resistance thermometers are also built. In these the motor operates the selector switch which connects the recorder to the different circuits and simultaneously turns a printing wheel which impresses upon the record sheet a dot to record the reading, and a number to identify the individual circuit which is being measured.

In the heat treatment of metals, it is becoming more and more the practice to bring the leads from thermocouples in different parts of the furnace and in different furnaces to a central control station. That is facilitated by the introduction of base metal thermocouples, which permits the prolongation of the couple itself to the measuring instrument, where the effects of temperature upon the cold end of the couple are readily compensated for, and by the adoption of the potentiometer method of measurement, with which difference in resistance of lead wires become immaterial.

An attendant at the control station uses an indicating instrument, which he connects successively to different thermocouples. Usually he is also provided with switches, by means of which he can light signal lamps for the guidance of the operators at the furnaces; usually a red light to indicate too high a temperature, a blue one to indicate too low a temperature, and a white one to indicate the right temperature. A multiple-point recorder is generally installed to record the different temperatures automatically, one after the other. The Leeds & Northrup multiple recording instruments, for example, are built for as many as 16 different circuits.

Where it is preferred to have the signalling at the furnace done automatically, a Leeds & Northrup "single-point" or curve-drawing recorder is provided with contacts on the moving element by means of which the signal lamps will be lit, accordingly as the temperatures in the furnace are too high, too low, or correct. An interesting extension of this plan is to use two thermocouples in different parts of the

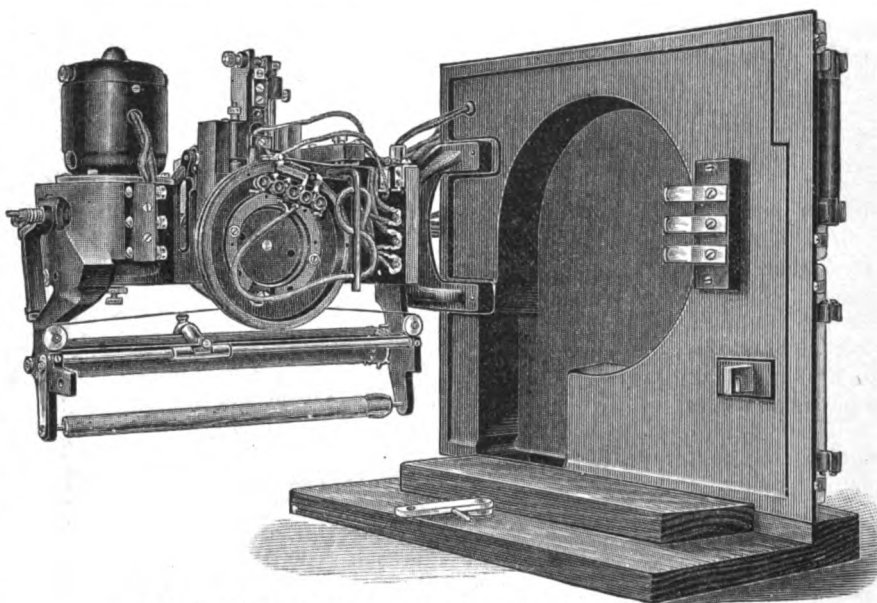


Fig. 1—Curve-drawing recorder opened for examination.

WITH THE EQUIPMENT MANUFACTURERS

furnace and to provide the recorder with a commutator by means of which it reads first on one and then on the other. The chart produced is a single line running alternately back and forth between the two temperatures and indicating the temperature difference graphically. At the same time the

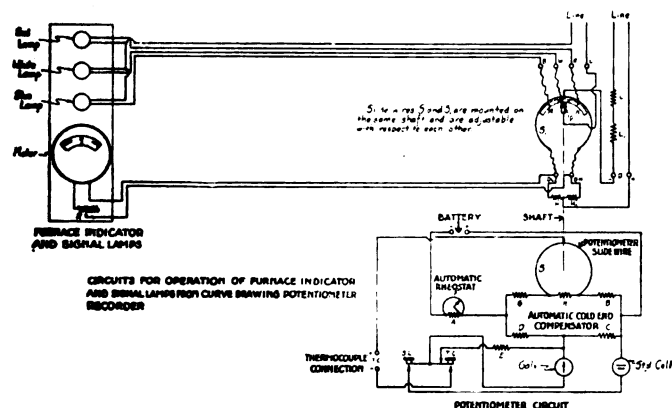


Fig. 2—Circuits of an automatic potentiometer.

commutator controls a fourth signal lamp at the furnace to show which thermocouple is being measured.

The double recorder is thus suitable for demonstrating uniformity of furnace temperatures, or the lack of it. It shows graphically the effects of empty furnace, full furnace, or part-full furnace, and how distribution of heat is affected by rates of firing, location of load, door and other losses, cold hearth, etc. It is a convenient means for investigating furnaces and showing how errors may be overcome by moving burners, baffles, or arches, or changing the method of introducing heat, as by the use of side burners, underfiring, overfiring, number of burners, position of doors, etc. It also shows definitely the effects of location of thermocouples, how the readings vary according to their placing with respect to

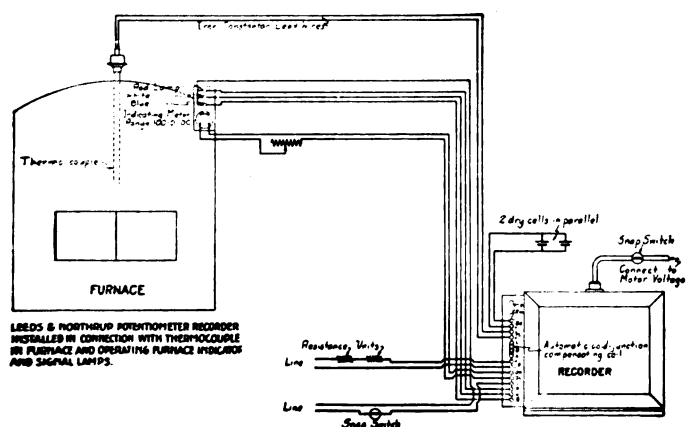


Fig. 3—Recording potentiometer installed in connection with thermocouple in furnace and operating signal lamps and furnace indicator.

the work and the burners, also the number of couples to be used in a given furnace, etc.

The use of this double recorder has exploded the old "staging heat" idea, since it demonstrates that it is practically impossible to bring many kinds of loads up uniformly to the

desired temperature by holding the furnace at a "constant" temperature, without underheating some parts, and overheating others. This type of equipment has been found of especial value in studying the heating of different kinds and

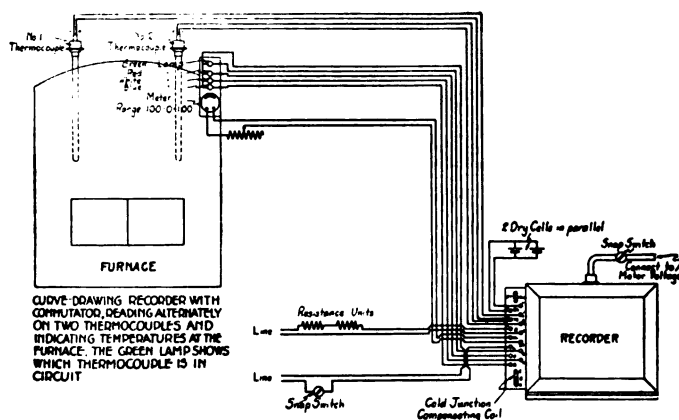


Fig. 4—Recording two thermocouples alternately.

sizes of sections or numbers of pieces, different methods of loading, speed of loading and unloading, mechanical furnacing, the heat treatment of large single pieces, such as gun forgings, etc.

ELECTRIC HOIST MANUFACTURERS MEET.

The Electric Hoist Manufacturers' Association held its June meeting at Montour Falls, N. Y., where the members of the Association were the guests of the Shepard Electric Crane & Hoist Company. Twenty-two members were present representing the following eight companies:

The Brown Hoisting Machinery Company, Cleveland, O.; Detroit Hoist & Machine Company, Detroit, Mich.; Euclid Crane & Hoist Company, Euclid, O.; Link-Belt Company, Nicetown, Pa.; Roeper Crane & Hoist Works, Reading, Pa.; Shepard Electric Crane & Hoist Company, Montour Falls, N. Y.; Sprague Electric Works, New York City; Yale & Towne Manufacturing Company, New York City.

The general topic of the meeting was war service and the general discussion was directed along the lines for co-ordinating the experience and facilities of the electric hoist manufacturers to be of the most direct and efficient service to the government for war requirements. The electric hoist manufacturers are heavily booked up on government orders for war purposes and the problem of securing raw material sufficiently in advance to promptly meet government requirements has become a critical one. The consensus of opinion of the electric hoist manufacturers is that government orders for war purposes should take precedence over all other orders, and if war requirements call for the complete output of all of the manufacturers of electric hoists, it will be desirable to refuse all other business.

The most instructing and interesting event of the meeting was a detailed inspection of the plant of the Shepard Electric Crane & Hoist Company, covering design, manufacturing, shop costs, testing, technical history of installations and welfare work.

Trade Notes

Effective July 1, the business of the Manown Manufacturing Company has been taken over by the Pittsburgh Coal Company and will, hereafter be carried on by that company and operations conducted as the Manown Manufacturing Company Department of the Pittsburgh Coal Company. This transfer will not involve any change in the operations as they affect the trade to be served. J. W. Barber, formerly vice president, has been appointed manager of the new department. Address all communications to the Manown Manufacturing Company Department of the Pittsburgh Coal Company, 1039 Oliver Building, Pittsburgh, Pa.

The United States Civil Service Commission announces an open competitive examination for safety engineer, for men only, for August 20, 1918. Vacancies in the Federal classified service throughout the United States at \$2,200 to \$3,600 a year, or higher or lower entrance salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion. Appointees to this position will have charge of the installation and maintenance of accident-preventing devices. They will be required to make a continuous survey of premises for unsafe practices and to inaugurate effective accident-prevention work; they will supervise methods of instructing workmen and others in "safety," and they will make such reports from time to time as may be required. Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated:

SUBJECTS.	Weights
1. Education	30
2. Experience and fitness.....	40
3. Thesis	30
Total.....	100

Trade Publications

Refractory Arches—The Green Engineering Company, East Chicago, Ind., has issued a booklet entitled "Capacity," which explains in detail numerous difficulties incurred in the economical operation of boilers, with particular reference to the problem of burning coal. It furthermore points out the application of "Geco" tile and "Seaflex" arches to this problem.

Steel Pipe—The National Tube Company, Pittsburgh, Pa., has issued a bulletin entitled "Service Every Minute," explaining the durability of "National" pipe.

Battery Charging Equipment for electric vehicles and industrial trucks is illustrated and described in a four-page two-color ($8\frac{1}{2} \times 11$ in.) pamphlet just

issued by the Cutler-Hammer Manufacturing Company, of Milwaukee and New York. Some of the distinctive points which are claimed to make universal sectional type battery charging apparatus of this kind the logical equipment are: adoption of a standard unit as the basis for forming panels and groups of panels; ability to make future equipment conform and be an addition to present equipment. Four large fleets of electric vehicles typical of those charged by C-H sectional charging equipment and 18-circuit, 18-section equipment are shown. Emphasis is laid on the importance of keeping the batteries of industrial trucks properly charged. The loss of only an hour a day, due to improper charging, cancels part of the big results obtained through the use of electric trucks. The adaptability of electric battery trucks and vehicles for all kinds of haulage problems is also emphasized.

Copper—The Bureau of Standards, Department of Commerce, Washington, has issued circular No. 73, entitled "Copper." This circular deals primarily with the physical properties of pure and of commercial grades of copper. The best data and values are given for the various physical characteristics and constants, together with a bibliography of the sources from which these values were taken. The effect of impurities upon the properties of copper is discussed as well as the influence of various factors in its manufacture. This paper is now ready for distribution and those interested may obtain a copy by addressing a request to this bureau.

Coke Oven Gas—The Cutler-Hammer Manufacturing Company is just publishing a booklet illustrating and describing the production and distribution of coke oven gas in the city of Toledo, and the application of Thomas meters for measuring large quantities of this gas.

Starting Switch—The Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., has just issued a four-page, two-color ($\frac{1}{2} \times 11$ in.) pamphlet, which shows four typical installations of the C-H 9116 starting switch for squirrel cage motors. Being entirely enclosed and having several safety features it protects both man and motor. An interior view shows the construction and arrangement of the starting and running contacts, fuses, etc. The manner by which the motor is connected to the line ahead of the fuses and then automatically engages the fuses, without opening circuit to the motor in the transition, is clearly shown. When the front panel of the enclosing case is lowered to inspect or remove fuses the switch is mechanically interlocked "open" and cannot be accidentally closed. The operating handle can be locked "open" with an ordinary padlock, thereby preventing accidental starting of the motor by unauthorized persons. Attention is called to the fact that the sizes made—up to 3 h.p., 110-volts and up to 5 h.p., 220, 440 and 550 volts—give this AC enclosed starter a wide field of application because of the extensive use of squirrel cage motors of these capacities.

Book Reviews

The Chemist's Pocket Manual—By Richard K. Meade. 530 pages. Price \$3.50. Chemical Publishing Company, Easton, Pa. Covers a wide scope in a brief manner.

Laboratory Manual of Bituminous Materials—By Prevost Hubbard. Octavo (14 x 23 cm.), xi + 153 pages, 39 illustrations. Price \$1.50. John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London. An advanced and specialized publication on highway construction.

General Chemistry—By Hamilton P. Cady, Ph. D. Octavo (14 x 20 cm.), xiv + 522 pages, 73 illustrations. Price \$2.25. McGraw-Hill Book Company, New York; Hill Publishing Company, Ltd., London. A reliable text containing general chemical discussion and data particularly relative to inorganic chemistry.

Obituary

John William Bell, superintendent of the Gulf States Steel Company, died recently. Mr. Bell was a native of Scotland and had been actively engaged in the coal mining industry during a large part of his career.

W. S. Kidd, for a long time identified with the drawn steel wire trade and connected with the Kidd Drawn Steel Company, Aliquippa, Pa., died at his home in Beaver, Pa.

Benjamin Seward Porter, secretary and treasurer of the Aetna Nut Company, Southington, Conn., died at his home. He was 71 years of age.

Society Meetings

American Chemical Society, Cleveland, O., September.

American Society of Sanitary Engineers, Chicago, Ill., September.

American Institute of Mining Engineers, Colorado, September 2-7.

National Association of Stationary Engineers, Cincinnati, O., Sept. 9-13.

Association of Iron, Steel and Electrical Engineers, Baltimore, Md., September 11-14.

British Iron and Steel Institute, London, England, September 12-13.

National Exposition of Chemical Industries, New York, N. Y., September 23-28.

American Electrochemical Society, Princeton, N. J., September 30-October 2.

Institute of Metals Division, A. I. M. E., Milwaukee, Wis., October 8-11.

Iron and Steel Members, A. I. M. E., Milwaukee, Wis., October 8-10.

American Foundrymen's Association, Milwaukee, Wis., October 7-12.

National Safety Council, St. Louis, Mo., October 14-17.

Business show, New York, N. Y., October 21-16.

The Blast Furnace *and* Steel Plant

Pittsburgh, August, 1918



Safeguards America's Most Important Industries

From Canada to Mexico throughout the breadth of the continent, numerous installations prove how the largest industrial corporations have solved their housing problems with permanent

Asbestos Protected Metal

Roofing and Siding

APM is immune to weather attacks and the corroding influences of acid fumes. It is readily applied to steel or wood building frames—saves time in construction and requires the minimum of labor to erect.

APM never requires painting or other maintenance expense. Its use permits of lighter structural members than any material of equal applicability. It is the economical, permanent roofing and siding sheet.

Bulletin 555 contains full details of APM Roofing and Siding and illustrates its use on a large number of buildings throughout the country. Send for a copy TO-DAY.



BETHLEHEM STEEL CO.,
South Bethlehem, Pa.



SMALL
SECTION
OF APM
SHOWING
HOW MADE

BALTIMORE DRY DOCK
AND SHIP BUILDING CO.

Aspromet  Company
Formerly Asbestos Protected Metal Co. Pittsburgh, U.S.A. 7/17